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Engineering News-Record

MODERN ROADBUILDING . . .

Greater construction problems resulting from traffic demands for uninterrupted movement, straighter routes and flatter grades have transformed and modified roadbuilding practices in recent years. High-quality management and wide utilization of equipment and mass production operations have been necessary to meet these problems effectively. This issue is planned to paint a panorama of progress in construction practices that they may be evaluated in terms of past performance and future promise. There will be found inside this cover:

A Review and Forecast
By Thomas H. MacDonald

The Past Year's Accomplishments
By Charles M. Upham

Modern Highway Location
By R. Getty Browning

Highway Grading With Machines
By H. J. Spelman

Concrete Road Construction
By E. M. Fleming

Laying Bituminous Surfaces
By Prevost Hubbard

Advances in Brick Paving Practice
By G. F. Schlesinger

Methods of Year's Record Program
By H. B. Henderlite

A Collection of Surveying Shortcuts

January 7, 1932

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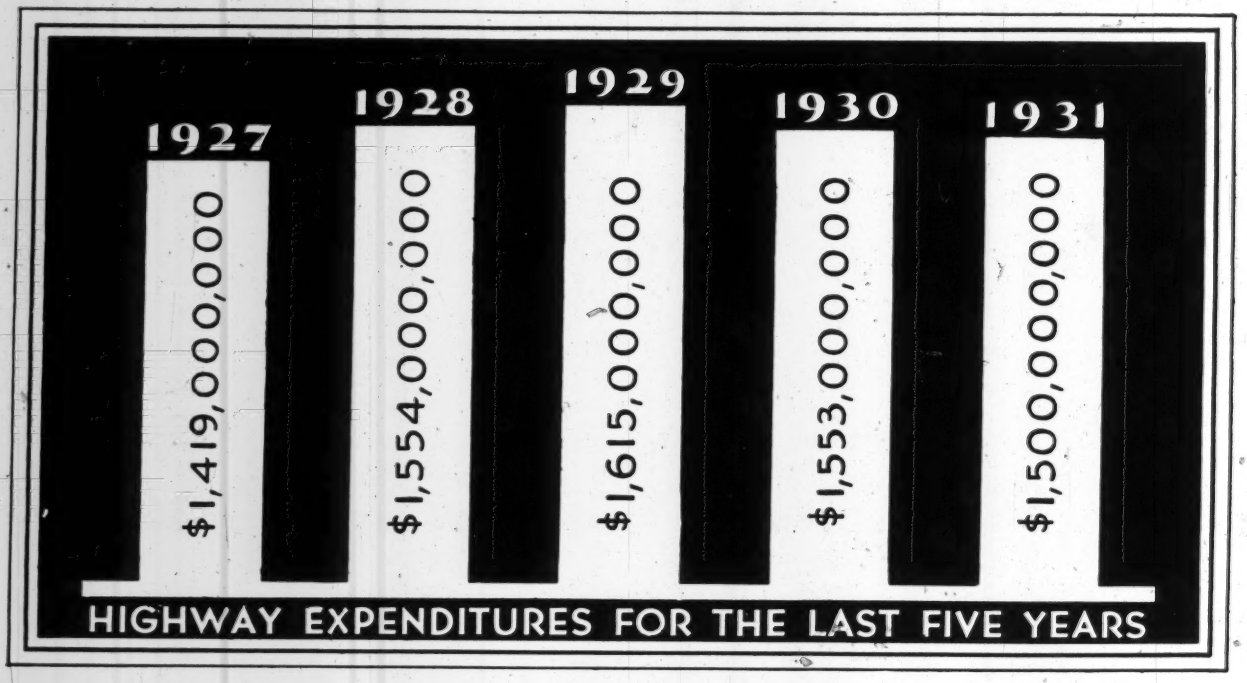
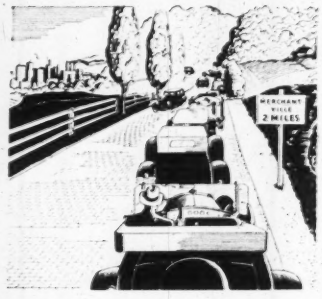


DURING the year just closed, at least one and one-half billion dollars were spent on highway programs, giving employment directly to 1,000,000 men and indirectly, through the manufacture of materials and equipment, to 2,000,000 more.



One result of the recent business depression, too easily overlooked, has been the Government's active support and encouragement of Good Roads projects. It has been responsible for the construction and reconstruction of many added miles of good roads and has created jobs for 3,000,000 workers. This is reflected in better transportation facilities.

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Engineering News-Record

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F. E. Schmitt, Editor

Volume 108 | New York, January 7, 1932 | Number 1

Highway Construction Enters a New Era

NEW problems in construction confront highway engineers. Within a brief decade the work of building main roads has changed profoundly. From a task extending little beyond surfacing it has developed to one of extensive line rectification and grade reduction, with surfacing hardly more than a finishing operation. In the same period traffic has become controlling. One result of these changes is that, while construction volumes became much greater through route straightening and grade reduction, the imperative necessity of preserving uninterrupted freedom of travel compelled the builder to shorten the construction time.

HOW IS the roadbuilder meeting his problem? This question is in part answered by a notable group of articles in this issue. Leading highway engineers discuss road location, grading and surfacing as they are being developed to meet the new demand. Such appraisal is needed for planning a new year of roadbuilding, one that promises to be greater than any of its predecessors. And the appraisal is particularly pertinent at the present moment, when the annual convention and machinery exhibition of the American Road Builders' Association is assembling.

LINE improvement is the first of the new controlling factors in construction. Mere surfacing of existing road locations, however perfectly done, does not adequately serve main-road traffic; the volume, speed and loading of present-day traffic call for straighter alignment and easier grades. Hence the importance of relocation.

Even the most moderate straightening of old roads shifts some property from main-road to side-road accommodation. In this transfer lies one of the most troublesome problems of location. The surveyor's task of choosing route, alignment and gradients and of adjusting cut and fill is ordinary in comparison, though often complicated by formidable difficulties of topography and soil. To shift old roads to new locations involves not only consideration of the physical value of the old road but also recognition of long-vested rights of residence on the main road and of public sentiment against change. In coordinating these intangible values with the costs of new line construction and with the gains to traffic of better line and grade, the new practice of road location calls for judgment based on ample data. Traffic surveys and valuations, therefore, become necessary tools of the locating engineer.

GRADING has evolved in comparable degree. Highway location reaches beyond its individual problems by aggravating the problems of grading and surfacing. It increases volumes, and therefore the new requirements of highway construction are that greater yardages of earth shall be moved at greater speed and that they shall be so placed as to entail the least delay in surfacing. These requirements are being met by increased resort to earth-moving machinery and by improved methods of solidifying subgrades, particularly on fill.

So extensive are the changes accomplished that highway grading has overtaken surfacing in the mechanization of its operations; subgrade preparation has become dominant in construction and research. Current development centers in plant coordination and in determining limits of adaptability and effectiveness of various devices. Refinement of machines is everywhere evident.

SURFACING began at an earlier date to take on the character of a manufacturing process in which plant management and production methods are controlling factors. Current innovations are therefore less striking. Changes from older practice consists in better coordinated plant and more efficient machine management, which conjointly have increased production greatly.

WHAT of the future? Its greatest opportunities lie in extending the practices successful in construction to other highway problems. As well pointed out in the leading article, the future problems of roadbuilding are many. Construction is the one that is most securely in hand; its course is along the path of further machine and plant improvement and production management. In finance, taxation and traffic regulation the course is less clearly marked. The chief reason is that the legislator and political executive have arrogated to themselves, without opposition by the engineer, all rights of highway management except engineering. The roadbuilder cannot afford to leave these matters to undirected legislation. He must apply research to administration and operation as he has applied it to construction.

Leading Articles

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NOTES OF THE WEEK

For Efficient Service

THOSE of our readers who take notice of such things as form and arrangement of printer's type will observe that *Engineering News-Record* with the present issue appears in new typographical dress. The change from our former practice represents an effort to give the reader more efficient service. Narrower measure and better balanced type size make a more readable length of line, and by their greater flexibility permit of arranging the page more closely in accord with the needs of easy reference from text to cuts. There is also a gain in concentration of information, with equal or better legibility. More matter will be made available in the same space. If we rightly interpret the needs of the present epoch as being for simplicity and utility, devoid of waste and with only such emphasis as is required for well-proportioned understanding, our new form will serve the interests of the reader effectively.

Cleary Takes the Reins

AN ENGINEER has been given the reins of the San Francisco city government as chief administrative officer under the new charter—A. J. Cleary, born in San Francisco and for many years occupying responsible positions in the city engineer's office. He comes to the administrative control of the city with an unusually intimate knowledge of its problems and needs. It is not uncommon for engineers to enter the field of city management work, but the usual procedure is to acquire administrative training in smaller cities with gradual acceptance of wider responsibilities. But in the present case any lack of managerial background is offset by thorough mastery of the problems at hand. And there is no question as to the magnitude of the problems to be encountered. The new administrator has an opportunity to show San Francisco what city-administrator control can accomplish if permitted the necessary freedom of action, and to further the growing belief that engineers are fitted for executive responsibility.

An Occasion of Pride

UNDISPUTED eminence in the field of construction has been attained by roadbuilding in its annual exhibition of machines and materials for road construction. Next week at Detroit, Mich., the clans will gather again. Again they will count up a performance in construction which surpasses that of any previous year. Again the technical divisions of the American Road Builders' Association will consider a group of professional papers and investigations greater in number and scope than those of prior meetings. This is a notable record following two years of business depression that have exacted a large toll of unemployment and loss of profit in almost every occupation in which men are engaged. The highway profession has further cause for pride in the fact that it has led all kinds of construction in giving work during the past summer to thousands who could not find it elsewhere. Even now it is carrying on through the winter with construction programs that mount into many millions of dollars. All of these things are reasons why the great conclave of roadbuilders at Detroit has cause to rejoice. The roadbuilders of America may justly approach their 1932 convention and exhibition in a spirit of pride—pride in work done to create transportation values, to give employment to men who have needed it, and to improve the materials and machines for performing their tasks. In this spirit the studies next week in convention chamber and exhibition hall will set a mark of courage and usefulness that no clouds of depression can dim.

Consider the Wearing Surface

WEARING surface is a term that has fallen into unwarranted disuse in pavement construction. Should it not be revived? A long-current fiction has it that the advent of rubber-tired road traffic eliminated abrasive wear as a factor in pavement destruction. The fiction can no longer survive; too many hard-surfaced roads have been resurfaced in the past twelve months to excuse inattention to any of the possible reasons for this activity. Doubtless the need for resurfacing arose from cracking, corner breaks, slab settlement and local surface disintegration, but just as certainly wear played a part in aggravating the original defects. That the rubber tire did not eliminate abrasive wear is proved by the many worn pavements that may be found everywhere. The rubber tire itself provides an excellent buffer for applying surface dirt as an abrasive, and often it carries chains; but even if the rubber were without effect, we would still have to consider the farm tractor and mowing machine and other steel-tired vehicles which use the paved roads. Thus it is a legitimate question whether road engineers should not restore the term "wearing surface" to their vocabulary of terms defining the elements of good pavement. Notable action in this direction is exemplified in the bituminous macadam construction of the last few years, particularly in New England: The surface of the latest of these roads is deliberately designed to be a mosaic of hard, tough, coarse crushed stone in which the binder appears only as a narrow joint material. The stone aggregate is the real wearing surface. It is worth speculation whether a similar device of construction does not promise usefulness in other cemented-aggregate types of pavements.

A Logical Solution

CALIFORNIA has removed a source of conflict between architects and engineers by establishing a registration subclass of *structural engineer*, applicable to those registered civil engineers who can show evidence of a prescribed amount of training and experience in building design. Men so qualifying are accorded rights similar to those granted to registered architects. The plan is simple, and should prove effective in ending a difficult interprofessional situation.

Elsewhere the same plan has met with strong opposition, notably in New York State, on several grounds. It is claimed to be unnecessary because the knowledge of the fundamentals of structural engineering required of all engineers is as high as similar knowledge required of architects. Again, it is claimed that the classification of "structural engineer" is too broad to be of value in defining those engineers who do building work. Third, it is argued that if a board of registration for engineers sets up adequate structural qualifications it will automatically set requirements much higher than those de-

manded of architects and thereby will discriminate against engineers whose structural engineering qualifications are higher than those of many architects but not high enough to meet its own requirements.

These are sound theoretical considerations, but they have little practical value. The California plan sets up a simple way of delimiting the engineers who wish to practice in the building field. Since it satisfies the demands made by architects and does not restrict the activity of engineers qualified in building design, it is a logical solution of a difficult problem.

Start Over!

CONSIDERATION of the four-system railroad consolidation plan for the trunk lines of the East begins before the Interstate Commerce Commission this week. This plan, submitted to the commission last fall by executives of the larger railroad systems, is proposed as a substitute for the commission's five-system plan. Railway conditions were bad enough when it was submitted; it was the counsel of desperation, presented in the hope of strengthening railroad credit. Conditions are worse today; the time has passed when an apparent agreement between opposing factions in the railroad field can do anything toward improving railroad credit. Much more is to be expected from the rate increase now in effect and from the anticipated lowering of wage rates. What then, if anything, has the four-system consolidation plan to commend it for consideration at this time? Does consolidation of the railroads into a few large systems hold out the same inducements that it held out when the transportation act was written, a decade ago?

The four-system proposal now before the Interstate Commerce Commission has little significance in the whole plan for railroad consolidation. Aside from the fact that it was submitted essentially as a move to strengthen railroad credit, it is but a minor step, a feeler to determine whether the Interstate Commerce Commission would accept such a four-system plan in place of its five-system plan provided *all* the obstacles in the way of such a plan can be worked out. The obstacles have not been fully worked out, as a careful study of the proposal indicates. But even if the projected consolidations could be made at once, the actual economies that would result are small.

In 1921, when the transportation act was written, gains to be obtained from consolidation were the preservation of the weak railroad lines by integrating them with the proposed big systems and strengthening the big systems by operating economies and by the elimination of wasteful competition while maintaining essential competition. Today the significance of railroad consolidation lies in its effect on the general transportation system of the country ten or twenty years hence. Ten years ago railroads were practically our sole means of long-distance transportation on land; now buses and trucks occupy a place of rapidly growing importance. Weak lines that then needed to be preserved as outlets for isolated communities have been abandoned, or should be, because trucks and buses now give a superior service. Ten years ago competition between railroad and railroad largely served to keep freight rates down; now competition between railroads and truck lines is becoming the controlling factor in ever-widening circles around major centers of traffic.

Expected operating economies also have been largely nullified. They were to be brought about largely through a reduction of labor forces by elimination of duplicate services. Now, however, labor leaders are so concerned over such a possibility that it is safe to assume that Congress will set up effective checks against wholesale discharge of railroad workers.

Thus it is evident that in the ten years during which the Commerce Commission and the railroads have struggled over making the consolidation provisions of the transportation act effective, the whole scene has changed. The future holds little promise for the major economies planned for ten years ago; rather it holds promise of permitting the railroads to pass through the present transition stage without major sacrifice if their planning for the future is wisely done. Assuming that the future is to bring a completely integrated transportation system —rail, truck, bus and barge lines—in which rails form the main trunk and buses and trucks do most of the short-haul and feeder service, then it is conceivable that our existing laws foster too much competition between railways. Maintenance of rail competition between sources of raw materials, between major centers of industry and between seaports is all that is necessary; truck competition and utility commission regulation can be counted upon to control other rates better than the costly duplication of facilities now maintained.

It is time to make a fresh start. Planning as to the make-up of large railroad systems that are to form the backbone of our land transportation network needs to start from a much more ideal set-up than is now contemplated. From that high starting point planning should work down to the best possible compromise between the ideal and the actual present-day grouping of the railroads. The recent consolidation agreement shows little semblance of having been worked out on such an ideal basis; nor does the commission's official plan. Both were worked out with too much consideration of the past and not enough for the future. New planning is needed. Congress should revoke the consolidation provisions of the transportation act and write in new provisions based not upon past conditions but upon the apparent needs of the future. What has been done to date is largely wasted effort. The planning should start over.

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Engineering News was founded in 1874 by George H. Frost, as The Engineer and Surveyor, which title subsequently became The Engineer, Architect and Surveyor, then Engineering News and American Railway Journal and finally Engineering News, under the editorships of D. McN. Stauffer, A. M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as The Plumber and Sanitary Engineer. The name was subsequently changed to The Sanitary Engineer, Engineering and Building Record, and, finally, to Engineering Record. During his ownership of the paper Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor of the paper in 1902 and was succeeded in 1913 by E. J. Mehren.

E. J. Mehren became editor of Engineering News-Record at the time of the consolidation in 1917, and was succeeded by Frank C. Wight in 1924. In July, 1928, F. E. Schmitt was appointed editor.

The editorial staff comprises:

New York: F. E. Schmitt, editor; V. T. Boughton, managing editor; M. N. Baker, C. S. Hill, W. G. Bowman, H. W. Richardson and C. N. Hulburt.

Chicago: E. E. R. Tratman, W. W. De Berard, F. W. Herring.

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San Francisco: N. A. Bowers, J. I. Ballard.

Urgent Problems Confront Public Roads Officials

Difficult problems of administration, financing, transportation and engineering remain to be solved—Local roads demand special study

By Thomas H. MacDonald
Chief, U. S. Bureau of Public Roads, Washington, D. C.

AS HIGHWAY BUILDERS we have become a little smug. The work accomplished possesses our thinking. We like to count it up in millions of dollars and thousands of miles. There is ample reason to be pleased with the count—it is the integer of the greatest single public-works activity that the world has known. It is not good for roadbuilding, however, to feed our pride altogether on retrospection, so a far-thinking roadbuilder has been asked to tell us plainly as he sees them some of the tasks that remain to be done. He has done this temperately and encouragingly in the article that follows. It should be read carefully, for the problems ahead are so great that all we have done in developing public roads to serve transportation is but the introduction to the great volume of work that has to be recorded as accomplished before the United States has a highway system and not merely a great mileage of highways. —EDITOR.

LOOKING BACK over the last 30 years of American roadbuilding and the associated development of highway transportation must, I think, inspire in anyone able to appreciate at all the difficult problems that have been met and solved a feeling of wonder that the progress has been so steady and the setbacks so few.

Some of us who are not yet willing to be classed as ancients have witnessed the whole remarkable process: the first horseless carriages, the steady improvement of automobiles, the shift of public reaction to them from ridicule through resentment o universal acceptance and grateful usage; the development of road types to resist the new forces imposed by the self-propelled vehicle; the gradual transfer of the burden of road cost to the motor vehicle; the growth of state highway agencies; the participation of the federal government; the mechanization of the roadbuilding industry; all culminating in the busy and efficient highway facilities of today.

But, though we may take pardonable pride in the overcoming of past difficulties, it is well to remember that problems still confront us that will take quite as much careful thought and planning. These problems that remain—some of them of the knottiest, and for that reason thus far evaded—lie in all highway fields: in administration, finance, taxation, traffic service and safety, and in the location, construction and maintenance of roads.

What to do about the administration of the large mileage of local rural roads is a question that should have early attention. As to the roads over which the state highway departments preside, there is no major administrative problem. But state agencies administer only about 324,000 miles of main highways. More than 2,500,000 miles of lesser roads remain under the authority of some 3,000 county governments and a larger number of township officials.

The very number of these local road authorities is sufficient to defeat the purpose of bringing about a condition of uniformity of administration of local roads. The size and wealth of the areas over which they have control are generally so limited as to prevent the economical application of adequate supervisory control and equipment, and the local officials themselves are particularly subject to that form of neighborly pressure that is so difficult for an elective official to resist and is so inimical to the rational administration of a highway program. Considering, therefore, the township, the reasons for its complete abandonment are so cogent as to make this reform a matter of urgent desirability. The case is not so clear as to the county.

State control of county roads

IN North Carolina the county officials have recently been shorn of all highway authority, and their former powers have been transferred to the state highway commission. Unfortunately, the experiment has been launched under difficult fiscal conditions that jeopardize the administration; but the results will be followed with keen interest by all who have a concern for the future.

In Pennsylvania and Missouri less drastic measures have been taken, involving the transfer of only a part of the remaining local mileage to state control; and these experiments also will bear careful watching.

The question to be answered is how best to apply needed expert supervision and the economies of consolidated control to local road work, and whether to do this it is necessary completely to abolish local control or whether a measure of local responsiveness consistent with our inherited ideas of government may be retained, with modifications, to meet the present needs.

There is much reason to believe that the situation demands, as a minimum, the creation of a centralized control of taxation, budgeting and purchasing, and at least strong advisory powers in the hands of the state highway agency to guide the choice of location and the character of local road improvement. Subject to some such restraint and guidance, it may be desirable to retain the local highway authority as the executive agency and to insure the expression of the local view.

Rational road classification

SO LONG as we maintain mutually independent authorities for the state and local roads there will probably continue in existence certain anomalies of road classification that militate against complete rationality of highway development and finance.

The roads that have been designated as state highways are generally those that connect the more important cities and towns and serve as the main lines of traffic flow. Broadly speaking, they are the roads of greatest traffic importance and are of general interest to the state at large.

The much greater mileage that remains under local control consists in the main of roads of purely local interest, which serve as feeders to and distributors from the main highways and railroads and render their principal service directly to the land to which they give access.

But, under existing conditions, it is perhaps unavoidable that there are included in the systems under state control some sections of relative unimportance, which partake more of the character of local roads than of roads of general interest; and, conversely, there remain under local control many roads that would more properly be placed under the authority of the general state agencies.

With control of the state highways and the local roads under separate and independent agencies, transfer of road mileage from one system to the other in most states is a matter requiring legislative action, and the transfers made are not always made upon rational or economic grounds. If, instead of the present dual control of the entire road net, there were single control under a state agency or something approaching such singleness of administration, the probability would be greater that a classification of the roads would be made upon the basis of their real character.

Finance and taxation

THE importance of a proper classification appears most clearly in consideration of the methods of taxation and finance to be employed. Local roads, properly so classified, are purely land servers. By improving access to the land they contribute to its value. Their traffic is relatively light and the amount of improvement they require is inexpensive. For the financing of such roads it is reasonable and proper to tax the land; and it will be found that such taxes will not be burdensome.

The state roads, if they have been

properly selected as roads of really general interest, have no such close relationship to the rural land through which they pass. They require a high type of improvement, which is necessitated not by the needs of traffic originating upon the adjoining land but by the accumulation of traffic brought to them by many feeders and by the large intercity movement. It would seem that support of such roads by vehicular taxes is entirely reasonable.

Utilization of tax funds

THE present methods of finance, considering the country as a whole, approximate this division of the burden upon land and motor vehicles, but there is no consistency of purpose or principle. There is a great deal of useless interchange of funds between state and county agencies, which tends to obscure the purposes for which money is collected and used. If it were clearly recognized that we have the two classes of roads to deal with—and I might add streets also, because there is in the cities the same division into local and general-interest thoroughfares—the solution of many problems of finance would, I believe, stand forth more clearly. Much misrepresentation, now practiced, of the purpose of highway expenditures and the incidence of taxation would under these conditions be impossible; and taxpayers, whether owners of land or motor vehicles, would have greater assurance that the taxes they pay would be used for a purpose that would bring them a direct return.

Application of the same principle would, I believe, bring a solution of the problem of the right of the cities to a portion of the motor vehicle and gasoline taxes. When we recognize that there are routes of general interest and local routes, the sections of the through routes that lie in the cities should have the same recognition and treatment as those that lie outside of city limits; and local streets in cities would also be recognized (as clearly as local rural roads) as a proper burden to be borne by real property.

Do heavy vehicles pay their share?

WITH acceptance of the motor vehicle's duty to pay the whole cost of the roads of general interest, there rises the question as to whether motor vehicles as a class are at present properly taxed to meet this cost, and whether the various types and sizes of vehicles are taxed proportionately to the expense that the provision of highways for their use entails. Weight, capacity or some similar measure of the size and load of the vehicle is at present a factor in determining license fees in all states, and gasoline taxes also mount with the size of the vehicle. The larger vehicles are, therefore, paying in some measure now for the greater expense of roads to which their operation induces. The question is: are they paying enough? Or, as I dare to suppose, in some states, too much? No informed person, I am sure, credits the misrepresentations that seek to establish it as a public belief that these heavier vehicles have free use of the highways.

It is important that studies be inaugurated in the near future in all states to determine exactly what the situation is with respect to the relative benefits and burdens of these heavier vehicles flowing from the roads provided by the public. A recent estimate, based upon necessarily approximate data, seems to show clearly that in Pennsylvania the license fees and gasoline taxes are already adjusted in such a way that motor vehicles, as a class, produce sufficient revenue to pay for the improvement of the entire state highway system of 13,300 miles, with each size of vehicle bearing substantially its proper share—even the heaviest trucks, which probably make use of only a part of the system.

Centralized control of taxation, budgeting and purchasing and strong state guidance of location and construction are advisable for local roads. Subject to such restraint, county highway autonomy is possibly desirable, but township administration of highways should be abendoned.

In the investigations that should be undertaken one of the important facts to be determined is exactly what roads are utilized by the heavier vehicles to an extent justifying the construction of the road surface of sufficient strength to withstand them; and, naturally, the vehicles should be held responsible only for that part of the expenditure that goes to make these roads adequate for their use.

Restriction of interstate traffic

ANOTHER question that will shortly have to be faced squarely concerns the attitude of the public to proposals from interested sources that various restrictions be placed upon the interstate movement of trucks and buses. The proposal in general takes the form of a demand for the taxation of these vehicles at the regular annual rates in all states in which they operate. In one state it is proposed to apply the tax to vehicles coming into the state if they make more than a single stop within the state's borders. If such efforts are successful, the multiplication of taxes will very seriously handicap interstate transportation by highway.

On the other hand, there is some reason in support of the plea that where a regular use of the roads of one state is made by vehicles owned in another commonwealth, the state whose roads are used is entitled to some compensation. It would seem that the existing reciprocity agreements amply cover the usually casual interstate travel of privately owned vehicles, whether trucks or passenger cars, since such interchanges tend to balance. The case may be different with respect to common-carrier operations and a few other movements that occur over fixed routes and on regular schedules. Here there is regularity of usage. The casualness and mutual benefit, which suggest the prevailing reciprocity agreements, are not present, and a different solution is justified.

A reasonable method of dealing with the situation presented, without imposing unbearable burdens upon legitimate and useful interstate commerce, would be to set apart the vehicles that engage in such traffic from private vehicles and, in each state through which they operate, tax them upon the basis of the known capacity-mileage of the vehicles operated. If the tax rate were properly adjusted, such vehicles would then be required to pay no more for their use of the roads than similar vehicles privately owned; but each state in which they operate would receive its fair share of their tax payment.

Coordination of facilities

THE least observant must see that these proposals for multiple taxation of interstate highway traffic are inspired by those who have at heart the interests of the railroads, or think they have. This suggests another problem, not exclusively pertinent to the highways, but nevertheless one that demands the most careful thought of highway officials as well as others, and one that cries most urgently for prompt solution. I refer to the proper coordination of the various transportation agencies operating throughout the country by rail, water, highway and air.

I have heretofore suggested, as a means of inaugurating steps toward such a coordination, the creation of a federal transportation board made up of representatives of existing federal agencies having to do separately with each form of transportation. Whether or not the agency be so constituted, I believe some such agency desirable, and it should, of course, be representative in its constitution of all the transportation facilities affected.

Vehicular weight, size and speed

WITH respect to those restrictions of motor vehicles designed to protect the roads, there is at last a virtually complete agreement in principle by all interests. In accomplishing so much the National Conference on Street and Highway Safety has been particularly effective. The provisions of its proposed uniform code have been adopted in large part by several states. What

remains is to reach an agreement on a few remaining points and then work in the most effective way to realize in law the principles agreed upon.

Agreement is practically unanimous upon a maximum height of 12 ft. and a maximum width of 96 in. The uniform code provision of maximum length—33 ft. for single vehicles and 85 ft. for trains—meets some reasonable objection: by motor vehicle manufacturers, who urge design necessities as the basis of a plea for a single vehicle length of 35 feet, and by many highway engineers who object on grounds of safety at curves to the train length of 85 feet. Some engineers incline to the belief that the maximum should be no greater than 45 ft. Motor vehicle interests would probably agree to a reduction to 65 ft. There is a pronounced feeling that the various interests affected are not far apart in their views, and it should be possible shortly, if the effort is put forth, to settle finally the long continued debate over these regulations.

Problem of design loading

THE American Association of State Highway Officials recently approved a resolution calling for the general acceptance of an axle load of 16,000 lb. and a wheel load of 8,000 lb. as the minimum restrictions to be placed upon load concentration on high-pressure pneumatic tires. Acceptance of these minima does not prevent the permission of greater weights in any state, but it does assure interstate traffic that no less will be demanded anywhere.

The association's approval is based upon the results of research, which show that wheel loads of 8,000 lb. on high-pressure tires will be safely supported with ample factor of safety by the prevailing heavy pavement designs. If, as seems likely, the investigations show that an increase to 9,000 lb. per wheel would be safe when carried on balloon or low-pressure tires, there is every reason to believe the association will modify its position accordingly.

The recent high-speed impact tests of the Bureau of Public Roads have shown that the effective impact of heavy vehicles is not increased between the speeds of 25 and 45 miles per hour. This means that between these speeds regulation must be based upon principles of safety only.

Highway safety

MUCH remains to be accomplished to make the highways as safe as may reasonably be expected. The menace of the projecting culvert headwall is easy to be rid of. The deep side ditch, which so often serves no necessary drainage purpose, can be eliminated, and its place can be taken where necessary by underground tile. Many curves are still dangerous, crowns too high, surfaces too slippery. The remedies for these conditions are well known. All that remains is to make use of them. And it is especially to be remembered at this time that many of these desirable improvements may give much needed employment to otherwise idle men.

It seems to me, however, that of all the needed improvements in the interest of safety, there are two behind which it is necessary to assemble the greatest pressure: (1) the elimination of dangerous grade-crossings; and (2) the construction of sidewalks in congested areas. Both of these improvements are hampered by inadequacies of law and the lack of cooperation of interested parties, as well as by limited funds.

For financing local roads it is reasonable and proper to tax the land. Roads of general service are rightly financed by vehicular taxes. Through routes that lie in cities should have the same recognition and treatment as those that lie outside the cities.

Means of expediting programs along both lines require the earnest thought of all who sincerely want to reduce the mounting toll of human life on the highways.

Subgrade research

IN THE fields of design, location, construction and maintenance, principles are fairly well established—or so it seems to me. The most important problem is that of the determination of the character of the subgrade and the development of means of improving weak soils. The vigorous research that is under way and that has already produced much of valuable suggestion must be carried on with all possible speed.

So far as vehicular effects are concerned, I am impressed that we already know them with reasonable accuracy and can deal with them adequately in design.

In the location of highways there is room for considerable improvement, particularly in some of the older eastern states, where early construction was designed to meet less exacting traffic demands.

The struggle for improvement in materials must go on without remission; and there is special need for the further development of materials and processes suitable for use on the more lightly traveled roads. In this field it will be well to maintain a constant search for new—perhaps radically new—methods and materials. The needs are low cost of construction and maintenance and an adaptability to mechanical performance of all processes either of construction or maintenance, in order that the large mileage involved may be benefited with the utmost speed.

There is just one further suggestion that I have reserved to the last. I am sure that there is need of more careful attention to the systems of expenditure control and record keeping in many of the state highway departments. The similar need in the offices of the local highway authorities is, of course, notorious; but I question whether much improvement may be expected there, as long as these agencies are without superior supervision.

However, there should be no longer any toleration of laxity in this respect in state offices. The principles of systematic accounting methods are well understood. Modern equipment is available, which permits records and accounts to be kept in such manner that even so active an operation as that of road construction need no longer be carried on without the most precise and up-to-the-minute knowledge of the progress of transactions from day to day.

Real efficiency and economy are difficult of attainment lacking such complete records and accounts. Dishonesty finds the lack its most effective ally. Political obstruction and criticism flourish when the administrator's reply is locked in the obscurity of uninformative records. The utterly indefensible lack of positive knowledge of the costs of maintenance arises from the same defect of the administrative machinery. There has been much talk on the subject. The time for action—vigorous and effective action in all the states of the Union—is overdue.

Georgia Stresses Use of Local Materials

WITH the abundance of local materials suitable for highway construction in the State of Georgia, the state highway board advocates the use of these materials wherever available and where suited to the type of surface warranted by traffic, subgrade and climatic conditions. The local materials consist of stone, sand, lime rock, top soil, clay-gravel, sand-clay and chert.

In making decisions on what type of base or surface is to be used on the different projects, due consideration is given to available local material. The problem of locating the material is one for the materials engineer, who makes a complete survey of all materials and reports in full as to their quality, quantity and accessibility. After material deposits are sounded out and representative samples are secured, these samples are sent to the laboratory to be tested for quality, and if found suitable, the location of the deposits together with an estimate of quantity, estimate of the overburden to be removed and hauling distance are furnished the contractors, who base their bids upon the use of these materials.

Typical examples of poor location of highly improved roads.

Highway Location Controlled by Engineering Economics

A review of the general requirements of good location, with examples of existing locations that exhibit both good and bad practice

By R. Getty Browning

Principal Locating and Claim Engineer, North Carolina State Highway Commission, Raleigh, N. C.

HIGHWAY LOCATION is primarily a problem of relocation. A road already exists, but traffic requires a more direct route with lighter grades, easier curves and better surface—a relocation and reconstruction. The requirements of traffic may be satisfied by moderate rectification of the old alignment, or they may demand a completely new route. The problem of the locating engineer is to appraise the service required by traffic and balance its value and the cost of a relocation somewhere between the extremes indicated. His task is complicated by the existence of the old road, which has an invested value in physical structures and an intangible but real value in the vested right of owners not to have the main road taken away from them. In presenting these factors the article that follows is a pertinent reaction on the economic theory of highway location.

—EDITOR.

THERE IS perhaps no phase of highway engineering that leaves to the individual engineer such a wide field for the exercise of good judgment and common sense as the location and relocation of highways. In most engineering problems he may have recourse to formulas that have been tested by trial and experience to the point that he may use them with the greatest confidence, but with location problems he frequently must base his conclusions upon facts that cannot be found expressed in mathematical terms nor placed in a formula for his future guidance. It follows that the proper solution of a highway location problem requires much preliminary accumulation of data.

Since most highway construction is undertaken to improve local traffic difficulties, the problem presented to the engineer is generally how best to improve the existing road to give the desired service at the least cost. In the rehabilitation of an existing highway to meet traffic requirements, the predominating considerations are:

1. Geographical direction.
2. Cost of constructing roadbed.
3. Cost of drainage structures.
4. Relative cost of maintenance.
5. Cost of securing right-of-way.
6. Service to through traffic.
7. Connections to intermediate towns.
8. Elimination of railroad crossings.
9. The use of existing road.
10. Local sentiment.
11. General appearance.

Based on these considerations, the engineer's judgment may lead him to conclude that the whole road should be abandoned and a new line developed. If he thinks so, how can he prove the soundness of his deductions?

He may feel that the old road is too steep, crooked and narrow, and that it would be too costly to reduce the grades, improve the alignment and increase the width, first, because of the heavy earthwork involved, as compared to a new location, and second, on account of the excessive property damage that would be incurred if the road were to be widened adequately. He may also feel that, if a new location were made, the old road would be relieved of so much heavy through traffic that it could be economically maintained for slow-moving local traffic with but minor repairs and a few short line changes. In such decisions one easily may err in either direction; he may spend too much in improving an old road or too little in developing a new one.

Before he can intelligently decide what is best to do, the engineer must be able to classify the road in question as to its present and future importance in the highway system. Its traffic volume, present and expected, must be appraised. With a clear understanding of these factors, a scheme of improvement can be worked out that should properly serve existing traffic with a minimum of risk that the proposed improvements may become obsolete within a very short time and necessitate extensive alterations or abandonment.

Considerable opposition frequently develops to radical changes in the location of a road that has been in constant use, perhaps for several generations. To meet this situation, careful studies to bring out all the facts are necessary to show the reasonableness and economy of carrying out the proposed changes. The public generally will approve a plan of improvement if it can be convinced of its soundness and the importance of its accomplishment.

The writer believes that all highway improvements should be preceded by a thorough traffic survey and classification of routes. Following this, limitations of curvature, grades, width, type of surfacing and cost per mile may be formulated, which are consistent with the character of the country to be traversed and the relative importance of the various links.

Let us assume that a traffic survey has been completed and an analysis made to determine what changes in the traffic volume may be expected in the future. The next step is to make a survey of the existing road to ascertain its alignment, gradients, width, character and condition of its surfacing, the adequacy of the drainage structures, the character of the soil, the amount of rock and its general nature, the approximate area of clearing and grubbing required; to determine whether or not the curves require superelevation and widening and, if so, the probable cost of such work;

to check the pole lines, water mains, gas lines, sewers, intersecting streets and highways, railroad grade-crossings, major stream crossings, and to investigate the probable cost of securing additional width of right-of-way where the old road must be widened. The location and extent of local material available for construction purposes should also be determined.

In a word, an investigation must be made sufficiently detailed and extended clearly to understand the exact conditions affecting the existing road and what cost may be incurred in improving it to meet the standards adopted for it. Let us now consider two distinct cases: (1) that the old road is to be remodeled or relocated to meet the requirements of a class A highway; (2) that the old road is to be improved to comply with the standards for a class C highway.

Application of data

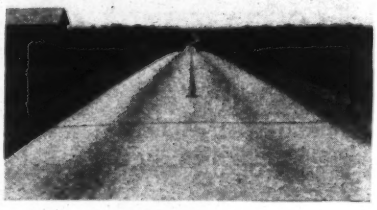
If the data secured on the survey are checked against the major considerations previously listed, it may be found that the old road cannot readily and economically be rebuilt to fulfill class A requirements, and that an estimate of the cost of doing so should be compared with the amount necessary to build an entirely new line.

Many heavily traveled old highways have curves and grades far below present-day standards; but situated as they are, perhaps in heavy mountain country or in some densely populated section, grade and line improvement cannot well be justified because of the tremendous cost involved. The accompanying table illustrates how any set of standards for location surveys may be affected by the prevailing topography. It is therefore the duty of the engineer

A location involving a bad highway and railway grade-crossing hazard.

to proceed cautiously in spending large sums of money to rebuild portions of an old road, when a more far-sighted policy would sustain him in changing the classification of the present road to a lower grade and in spending the money upon a more modern location.

The writer has in mind one road where the distance between two towns was reduced 9¼ miles by effecting a relocation. The new survey traversed practically the same country as the old road and provided about the same local service. The saving in distance was made by crossing over ridges rather than going around them and by crossing side ravines at their mouths rather than bending the line up one side and down the other. This plan required rather heavy earthwork and one bridge more than 100 ft. high, but the curvature was improved to the point that at least 300 ft. of visibility was provided at all points. In this case the controlling factors were the improved geographical direction, the reasonable cost of grading,



Poor location may be responsible for a crooked road in flat open country.

Abrupt curves on a bridge approach justify a considerable expenditure for their elimination.

better vision on curves, better service to through traffic without loss of local service, cheaper maintenance due to the shorter distance, and better exposure to the sunlight.

In all highway-location studies the effect of public sentiment should have the most careful consideration by the engineer. It may be favorable to his views or antagonistic. Generally speaking, the engineer is looking farther into the future than the average layman, and consequently it may require great tact and much patience to persuade the public to ignore local and personal considerations and adopt a plan more in keeping with future traffic requirements.

Another very important feature of highway location is the matter of public convenience. All highways should provide the most convenient means of travel for the greatest number of people, but it should always be remembered that by far the greater number of travelers using a highway do not live along it. That is, the traffic volume is largely

SUGGESTED MINIMUM REQUIREMENTS FOR SURVEYS FOR VARIOUS CLASSES OF ROADS IN DIFFERENT TYPES OF COUNTRY

	Coastal and Plains	Rolling and Hilly	Foothills and Mountains
	Class A	Class A	Class A
Width	30-35	30-35	30-35
Type	Concrete or asphalt	Concrete or asphalt	Concrete or asphalt
Curve	6 deg.	10 deg.	30 deg.‡
Grade	5 per cent	7 per cent	8 per cent
Vertical curve	*	*	*
Grading per mile	9,000 cu.yd.	15,000 cu.yd.	30,000 cu.yd.
Sight distance	500 ft.	500 ft.	300 ft.
Dist. between curves	500 ft.	300 ft.	140 ft.
	Class B	Class B	Class B
Width	30-35	30-35	30-35
Type	Sand, asphalt, gravel, sand-clay or macadam	Sand asphalt, gravel, sand-clay or macadam	Sand-asphalt, gravel, sand-clay or macadam
Curve	10 deg.	15 deg.	*50 deg.
Grade	5 per cent	7 per cent	8 per cent
Vertical curve	*	*	*
Grading per mile	6,000 cu.yd.	8,000 cu.yd	20,000 cu.yd.
Sight distance	400 ft.	300 ft.	300 ft.
Dist. between curves	400 ft.	200 ft.	140ft.
	Class C	Class C	Class C
Width	24 ft.	24 ft.	24 ft.
Type	Sand-clay, topsoil, gravel or macadam	Sand-clay, topsoil, gravel or macadam.	Sand-clay, topsoil, gravel or macadam
Curve	20 deg.†	20 deg.†	60 deg.†‡
Grade	5 per cent	7 per cent	8 per cent
Vertical curve	*	*	*
Grading per mile	5,000 cu.yd.	7,000 cu.yd.	10,000 cu.yd.
Sight distance	300 ft.	300 ft.	300 ft.
Dist. between curves	200 ft.†	150 ft.†	100 ft.†

*Not less than 200 ft. Longer if necessary for 300-ft. vision.

†On class C roads, curves may be reversed to reduce cost of grading, provided central angles are small and sight distance is satisfactory.

‡Curves of 3 deg. and more to be spiraled, widened and superelevated.

General note: Where the central angle is greater than 45 deg. the lightest curve consistent with the allowable yardage should always be used.

Steep, crooked and narrow roads often are necessary in mountain locations.

made up of vehicles traveling to and from rather distant points, and for this reason their convenience, rather than that of the individual living along the highway, should be given the most weight in deciding this question.

The safeguarding of human life and the reduction of property losses from highway accidents merit the most careful concern of the engineer, and in view of the appalling casualty lists arising from such mishaps he should not hesitate to remove every possible hazard from the roads under his jurisdiction.

We know from experience that certain conditions promote or cause accidents, and a determined effort should be made to overcome as many of them as possible on each location. Attention might be called to the following: sharp blind curves; abrupt vertical curves at the apex of two steep grades; sharp curves that are not superelevated; curves that are highly crowned and not sufficiently wide for two cars to pass inside the crown (this is very dangerous on steep grades); abrupt curves at the approach to narrow bridges; railroad grade-crossings, particularly those that are blind or partly so; locations that closely parallel a railroad or car line and after crossing the track at grade continue alongside the track; abrupt connections to intersecting highways, especially if one or both roads are in a cut and any decided break in the alignment or grade exists that restricts the driver's vision to less than 300 ft.

How far one should go in his efforts to avoid the various danger points or how much he might be justified in spending are matters that can be decided only after the engineer has carefully studied his problem from every angle, with the determination to achieve a result consistent with the three prime requisites of a modern highway location: safety, convenience and economy.

Possibly no other great public improvement is so frequently undertaken with no thought of the future as is road-building. Many miles of existing road bear testimony to the fact that they have been built to serve some selfish purpose or without proper consideration for increasing and faster-moving traffic.

Highway improvements should be carried out in the most economical manner, in the sense that a very expensive location should not be adopted when but little service can be rendered either at present or within a reasonable period in the future. On the other hand, it would probably be equally extravagant to build a poorly located road, even with a low type of surfacing, if there is a strong probability that it soon would have to be replaced by a much better location and a heavier pavement.

If expensive bridges or grade separations have been built on the poor location, the matter of changing it is further complicated.

If every highway location were to be worked out with a full appreciation of its present and future importance, further improvements could be made with the minimum of confusion and waste. Until this is done we may expect to see many badly congested roads proposed for improvement where no economical plan can be devised to relieve conditions without scrapping the old road and building a new one.

Note-Keeping Method Stresses Detail

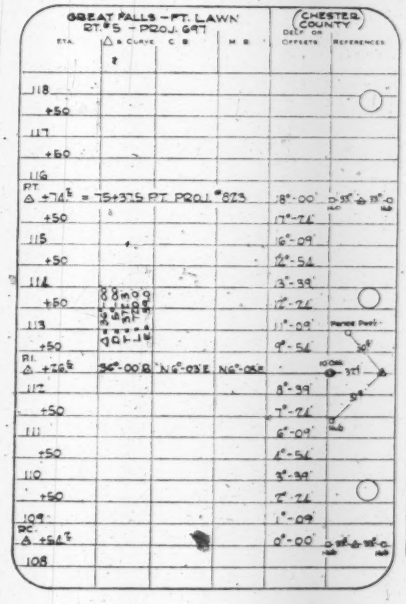
By F. M. Reeves
Assistant Locating Engineer, South Carolina State Highway Department, Columbia, S. C.

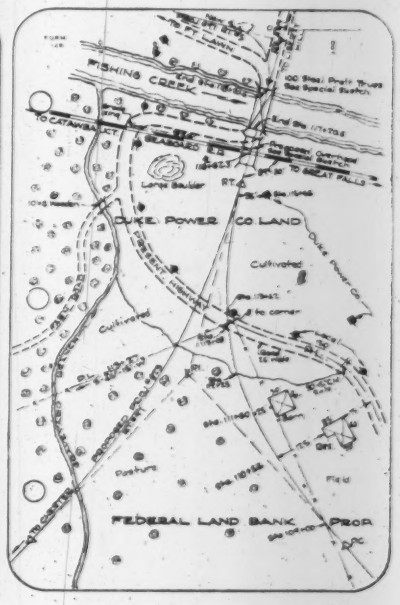
THAT note keeping is an art and truly represents the man on the job is thoroughly impressed upon all survey party chiefs on location with the South Carolina state highway department. As all plan work is completed to final stage in the central office by men who never see the job, it is imperative that the notes coming in from the field be clear, complete and accurate in every detail.

Further to clarify the notes, special sketches are required of all grade separations, bridge locations, culverts and sewer and water systems in small towns. In addition to these the chief of party is required to furnish a field layout or traverse of the existing road with topographical features indicated on it, and a field plan and profile roll showing alignment, topography, recommended grades, drainage areas and recommended structures. Much stress is laid upon securing accurate topographical details, such as property lines, county lines, city limits, houses, railroads, intersections, existing drainage structures, streams, fences, telephone poles, light poles and wood lines.

These details are of much aid to the locating engineer in his field inspection of plans before they are completed, and are of much greater aid to the right-of-way engineer, who uses the finished plans in securing rights-of-way and completing his permanent records. When the red line on the right-hand page of the standard notebook is used as the center line on curves and intersections, the topographical features are distorted and are not shown up very clearly. For this reason the form of note keeping illustrated has been devised and adopted as standard.

Reduced fac-simile of fieldbook sheets shows careful detail.





Modern road grading calls for heavy excavation and high-power equipment.

Machinery Revolutionizes Highway Grading

Greater volumes, reduced time, better placing and freedom of traffic movement have greatly magnified machine operations in road excavation and embankment

By H. J. Spelman

Senior Highway Engineer, Bureau of Public Roads, Washington, D. C.

MODERN ROADBUILDING requires large volumes of earth and rock to be moved with speed and placed with care. This demand has been met by as complete and perfect an array of machines as is found anywhere in engineering construction. The following article by an engineer experienced in heavy grading operations is therefore primarily an inventory and appraisal of grading equipment. In a measure, however, this analysis is of secondary importance to the forceful conviction that the article conveys of the magnitude of earth handling as a roadbuilding activity. Older estimates of road improvement, as chiefly a surfacing operation, continue to hold true only in local road improvement and frequently not even in this. Main roadbuilding except where the ground surface is remarkably favorable is largely a grading operation and in rough country preponderantly so. —EDITOR.

GRADING has now become a major operation and an exacting part of the roadbuilder's work. The large increase in yardages required to be moved by reason of lessened curvatures and grades and increased widths of roadway; the increased care that must be exercised in compacting and placing these increased yardages in embankments, and the necessity of doing this work rapidly to reduce the time of delays to traffic, and in many cases without entirely closing the road to traffic, have greatly magnified grading operations. Fortunately for the roadbuilder the development of new types of equipment, the adaptation of new forms of power to older types of equipment and the improvements in design and manufacture of equipment have kept pace with the increased requirements, so that the larger volumes are moved and placed under increased difficulties at decreased unit costs.

Reasons for increased grading

Roads are now designed for average speeds of from 40 to 45 miles an hour and occasional speeds of 60 to 70 miles an hour. The high speeds, as well as the increase in the number of trucks and buses using the roads, make necessary wider lanes of traffic and greater superelevation and longer sight distances on curves, as well as more traffic lanes. Where a sight distance of 400 to 500 ft. was formerly used in design, the recent recommendation of the committee on road design of the American Association of State Highway Officials calls for an 800-ft. minimum sight distance, and more if feasible, for trunk-line highways. The same committee recommends 8-ft. shoulders and 10-ft. traffic lanes, or a 36-ft. roadway section for a two-lane trunk-line road, as compared with the 26- or 28-ft. roadway section in use but a short time ago. Similarly, this committee recommends alignment for trunk-line roads as straight as feasible with 2-deg. 30-min. curves as an approximate maximum and 5 deg. as maximum.

It is, of course, impossible to meet these standards completely in mountainous country, yet curves with minimum radii of 100 and 200 ft. can often be obtained. Maximum curves of 8 and 10 deg., with 30- or 34-ft. roadway widths for two-lane traffic, are not now at all unusual standards for some projects in mountainous states such as West Virginia.

These greatly improved standards of width and alignment, with the increased rates of superelevation now used, have increased the volumes of material to be excavated for highway construction. Other factors that have contributed to increased volume of excavation have been the raising of grades high enough to avoid or to minimize drifting snow, or to get above infrequent high water.

Not only have the volumes to be moved been greatly increased but it is now impossible to close roads to traffic for as long a time as formerly, because of the possible disturbance to the life and business of the community, and in many cases traffic cannot be entirely diverted to other roads but must be carried along the site of the work either on temporary roads or by grading part of the roadway at a time. This is particularly true of the widening or relocation, or both, of old paved roads to

enable them to carry larger traffic volumes more rapidly.

As the time for the grading operations has been shortened, so, too, the interval between the completion of the grading and the placing of the pavement or surfacing has had to be shortened in the interests of better service to traffic. This means that more care than ever must be given to the proper compaction of the fills. Where it is possible to place temporary surfaces of traffic-bound material, as on new locations, this should be done. This is not always possible, but it is often possible to pave most of the project and use temporary surfacings on the deeper fills, deferring their paving a year or two. In any event the compaction of the fills has assumed new importance in many cases.

So, then, grading operations have assumed increased importance because the highway builder has now greater volumes of material to move and less time in which to move them, must exercise increased care in placing them and meets increased difficulty in carrying on the operations because of traffic movement.

Equipment progress

The development of equipment has kept pace with the increased demands upon the roadbuilder. New types of equipment have been developed and increased operating efficiencies are being obtained with the equipment because of continual improvements in design and manufacture. The two principal contributing factors to the present high state of efficiency of grading equipment are the internal combustion engine and the crawler-type traction.

The power shovel operated by an internal combustion engine and moving on a crawler track is the outstanding piece of excavating equipment and will probably remain so. Dipper capacities of 1 and 1¼ cu.yd. are the rule, with a tendency toward the larger size. Other types of excavating equipment have a place in highway grading work, of course. Elevating graders in prairie states attain an efficiency probably not reached by other equipment under like conditions, and wheel and fresno scrapers, hauled by tractors, are also efficient for certain work. The power shovel, though, in mountainous and rolling country, is the most efficient equipment yet developed, has many uses elsewhere, is the best all-round excavating tool we have, and does the great bulk of the grading work.

Teams and manual labor are mostly things of the past. Team-scraper outfits are still in limited use and will continue to be used for the smaller jobs, particularly in the agricultural sections, where horses and mules are available locally.

Steam power has been largely displaced by the internal combustion engine because of the increased facility of operation, the greater dependability of the power and the decreased operating costs of the power unit.

For rock excavation, air drills are used almost entirely, replacing hand drilling and steam drills. The portable compressor, operated by gasoline engine, is indispensable for this work. Larger compressors operating more drills seem to be the trend. In deeper cuts, well-drilling machines are sometimes used very effectively. Here, too, steam power has been displaced.

Horses and mules have been almost if not entirely displaced for hauling excavated material. Even on the mountainous locations comparatively little casting work is now permissible because of the greatly improved standards of alignment, so that practically all material has to be hauled. Both motor trucks and tractor-hauled crawler wagons are used. The crawler wagons possess the obvious advantages of being able to work in practically all soils in wet weather and to negotiate steeper slopes. Apparently they generally represent the cheaper method of movement up to 600 ft. of haul. For widening work on existing pavements, for long hauls and for work in close quarters and on narrow roads, the motor truck is usually necessary. Pneumatic-tired trucks of about 2½-cu.yd. body capacity are the most used, because they are less likely to bog in bad ground and are easier to get out if bogged, and because they will turn in a lesser radius.

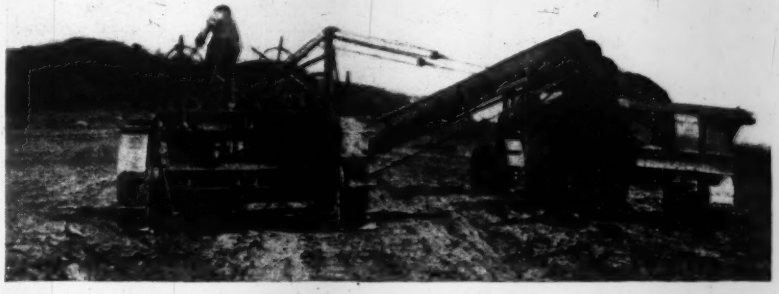
Rails and cars for hauling have been largely abandoned, partly because of their lack of flexibility, but probably more because of the difficulty with them of building fills in layers and properly compacting them. The use of trestles in building fills is not ordinarily satisfactory for the same reason.

The use of the dragline excavator would appear to present some possibilities in grading from side borrows. Often this type of equipment has not been permitted because fills made with it were not satisfactorily spread in thin layers. With the use of heavy spreading equipment, however, such as the bulldozer, it would appear possible to meet the necessary requirements for spreading in layers.

Road machines are particularly effective and economical equipment for light grading of turnpike sections, and their use and effectiveness have been greatly improved by the development and use of the heavy crawler-type tractor.

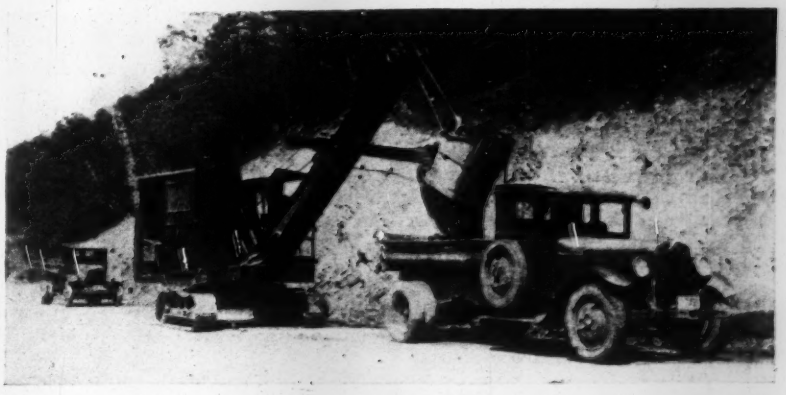
Compaction of fills

Embankment compaction and the value of the various types of equipment used for that purpose are still troublesome questions. Until a few years ago reliance for compaction was generally placed, according to the specifications at least, on placing the fills in layers and rolling the layers with a 10-ton tandem roller. Now various other methods of compaction are in use, such as depending upon the truck wheels or crawler tracks of the hauling equipment, water jetting, ponding or the use of the sheeps-foot roller. End-dumping of fills with reliance on the action of nature and the elements to compact and



Elevating grader (above) and tractor wagons highly efficient in favorable soils.

Widening operations on paved roads (below) particularly favor truck haulage.



Tractor hauling fresno type scrapers good for short-haul shifting.

Tractor-hauled scraper-wagon sublimates the familiar wheelscraper.

settle them, although still used to some extent in mountainous areas, is a practice that should practically disappear under present-day needs. The construction of fills in layers and the use of heavy mechanical equipment, such as the bulldozer or heavy road grader, to spread them is essential to good compaction. The depth of such layers should generally not exceed 12 in., unless the fill is mostly rock, where a depth of 24 in. ought to be satisfactory. In constructing fills across swamps it is usually necessary to make the first layer as thick as 24 in. in order to get sufficient stability for hauling.

Water jetting has produced some splendid results, but also some very unsatisfactory conditions where improperly used or where used in soils for which it is not adapted. Further study is needed now to determine types of soil in which jetting should not be used and to determine variations in methods needed for various types of soil. Ponding, which has given excellent results, is likely to be used more in the future, particularly on fills approaching and back of bridge abutments, where extremely bad settlements often take place and a water supply is usually close by. Here, as in jetting, care must be taken as to the class of material.

Research is now under way on a joint project by the American Road Builders' Association and the Highway Research Board to determine the relative effectiveness in compaction of the tandem roller, truck wheels, track wheels and sheeps-foot roller on various types of soils. All of these methods are now used quite extensively, and the results of this research should determine the extent and manner in which they will be used in the future. This is the most important question of their future use. It would seem obvious that if any of the equipment used in hauling is found to provide suitable compaction, certain savings in construction costs will result from reliance upon this, rather than upon the roller or jetting or other special equipment.

In the construction of fills across swamps from 7 to 20 ft. deep, the New Jersey practice of dumping upon the top of the swamp practically all the required fill volume and then blasting out from under it the soft unstable material so that the fill prism drops into place has given very satisfactory results. The sudden dropping of the fill through the height involved apparently produces satisfactory compaction, since no material settlement has been found on fills constructed by this method.

The use of hydraulic fills across swampy lands or along river shores has also been very satisfactory. Little or no settlement is likely in this type of fill. Side slopes will vary from 1 on 7 to 1 on 30, depending upon the class of material pumped. Gravel will stand on the steeper slopes, while the lighter sands require the flatter slopes. Although these slopes double the quantities of needed material over the ordinary 1 on 2 slope when the steepest possible hydraulic slope is used and multiply them several times over with the flatter hydraulic slopes, yet because of the low unit costs of hydraulic fills and often because of the inaccessibility of land borrowpits, hydraulic fills are economical. A further contributing factor in shallow water crossings or along river and lake fronts is that the flat hydraulic slopes are similar to beaches and eliminate the necessity of expensive riprap or other slope protection. Materials suitable for hydraulic fills are sand, gravel, shell or clay that is sufficiently stiff to be discharged from the pipe line in the form of balls, and the latter only when discharged in company with an appreciable amount of sand.

Costs of grading

Although the difficulties attendant upon grading operations have increased in the past decade, unit prices have been steadily lowered. Part of this is due to the increased volume of material moved, and part of it in the last eighteen months has been due to lower wages paid, but the greater part of it has been due to the new uses of gasoline power and crawler treads, the improvements in design and operating capacities of equipment, the development of equipment reducing the number of men required for the various operations, the adoption of two or even three shifts in construction operations and increased efficiency in equipment operation.

Modern methods require such great investments in equipment and improved designs render this equipment obsolete in so short a time that working several shifts to keep it in use 16 to 24 hours a day is almost essential to meet the competition of present low unit costs. Probably no better example of increased efficiency can be found than a comparison of the present gasoline shovel with the traction steam shovel of ten years ago. The steam shovel moved forward on mats and required two or three pit men to prepare the roadway and assist in placing the mats—an operator, a fireman, either a team to haul water and fuel or a pumpman and pipe line, and a night watchman to keep up steam so as to start in the morning. The present gasoline shovel requires only an operator, with daily or twice daily servicing of gas, oil and water by a service truck. One man has taken the place of six or seven.

Future developments in grading equipment will probably lie in the direction of further improvements in the design and manufacture of the types of equipment now in use, with possibly

Tractor-grader units maintain importance as earth-moving equipment.

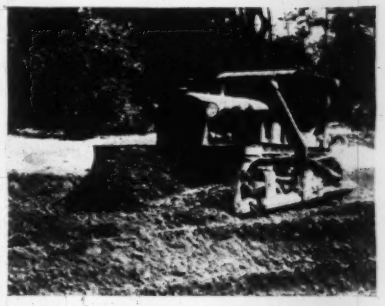
Sheeps-foot roller and tractor an excellent unit for compacting fills.

some increases in sizes, rather than in the development of new types.

The most interesting future possibility in construction equipment appears to lie in the diesel engine. As steam power has rapidly been displaced by gasoline in all grading equipment, so it is quite possible that the present gasoline motor will be replaced largely by the diesel engine in the years to come. It is claimed that equipment using this latter type of power will have longer life than that powered with gasoline, but just how much longer cannot now be said. It is also claimed that it will consume less fuel and a considerably cheaper fuel than gasoline. At present the original market price of equipment powered with diesel engines is materially higher than that of the gasoline type and it is a question whether the fuel saving and longer life of the diesel justifies the added investment. As more equipment powered by diesel engines goes into use, we can look for reductions in the original costs of the equipment; and it may be that this type of power will in the coming years effect still further reductions in the costs of grading work.

The improvements in excavating, drilling and hauling equipment have to a certain extent reduced the necessity of classifying material and have materially reduced the cost of rock excavation and handling. At the same time the use of trucks for hauling has materially reduced the costs of overhaul. For these reasons it seems reasonable to look for longer limits of free haul in future specifications, and a further extension of the use of the unclassified rather than the classified specification for excavation.

Traffic handling during grading operations has assumed great importance. In general there are three ways: by diverting the traffic to another road; by handling it on a temporary road along



Tractor-bulldozer meets the requirement for constructing fills in layers.

or close to the site of the work, or by handling it through and over the actual operations. Oftentimes a combination of these methods can be used. The diversion of through traffic to other routes is usually easy, but diversion of local traffic is not so easily accomplished. Where it can be done without too greatly increasing the distance to be traveled, it should be done because of increased public satisfaction and comfort and lower construction costs.

In the widening or reconstruction of old paved roads better to adapt them to modern standards it is usually possible to carry traffic along or through the road. Since the salvage value of these old roads is often slight, more drastic relocations are often justified so as to permit traffic to use much of the old road during the construction of the new one, particularly where right-of-way costs are not excessive. In widening, where existing alignment and grade is to be held to rather closely, traffic may be handled on single lanes through the work by means of watchmen, with occasional short delays for blasting. Such work should usually be done with a provision limiting operations to the dry season, say from April to November. In similar work where material changes in grade are made, the present roadway widths usually permit the cuts to be taken out half at a time, and a similar provision as to doing the work during the dry season will usually take care of the traffic, although it may be necessary to provide light temporary surfacing through the cuts in the event of rain. In all of this work it is important to provide for frequent blading to keep the road smooth for traffic.

Contractors doing work of this kind have in some cases found increased efficiency in doing it at night, because of the lessened interference by traffic, and it is feasible in the case of heavily traveled day-time roads to provide in the contract that work must be done in only one shift, say between 8 at night and 6 in the morning. The increased efficiency in operation would in some cases equal the increased equipment interest. Unquestionably, modern highway demands will require more and more grading work to be done without closing the roads to traffic, and the ingenuity of highway builders will be taxed to accomplish this at low costs and with minimum interference.

Form for Tabulating Highway Earthwork

By A. F. Sure

Engineer of Surveys, Maryland State Roads Commission, Baltimore, Md.

IN THE computation of earthwork quantities, a form usually called an earthwork sheet is used for tabulating the results. The engineering department of the Maryland state roads commission uses the form illustrated herewith. The left side of this sheet shows the preliminary quantities of both cuts and fills after computation. The center is used for the revised quantities owing to line or grade changes, which, in turn, are substituted for the original figures. Approximate estimates for approaches, side ditches or any work not covered in the earthwork sections are placed in these columns. All totals are summarized on the last sheet, where the usual 25 per cent shrinkage allowance is added to the fill quantities and where the differences between the cut and fill quantities are shown, indicating either borrow or waste. The quantities as determined by the final survey are shown on the right side of the sheet.

This method provides not only a complete setup of the earthwork computations without perusing cross-sections, plans and survey notes but is most convenient for balancing the earthwork.

Earthwork Computation Form.

COMPUTED BY _____ 19
CHECKED BY _____ 19

STATE OF MARYLAND
STATE ROADS COMMISSION
COMPUTATION OF EARTHWORK ON _____ COUNTY
_____ ROAD CONTRACT _____

	STATION	CUT			FILL			CHANGE IN GRADE				FINAL ESTIMATE			
								CUT		FILL		CUT		FILL	
		AREA	CUBIC FEET	TOTAL CUBIC FEET	AREA	CUBIC FEET	TOTAL CUBIC FEET	AREA	CUBIC FEET	AREA	CUBIC FEET	AREA	CUBIC FEET	AREA	CUBIC FEET

Concrete Road Construction Marked by Precision

Major processes and equipment exhibit greater precision and perfection of detail, with increased output and reduced cost of paved surface

By E. M. Fleming
Manager Highways and Municipal Bureau, Portland Cement Association, Chicago, Ill.

THE success of concrete pavement, as of other pavements, begins with the subgrade. Notable advances are now being made in subgrade treatment. Several years ago Iowa started the use of tar paper on loess subgrades to prevent absorption of water, and the reduction in hair checking proved so satisfactory that the practice was also adopted in Nebraska, where similar soils were common, and in 1930 the Iowa highway department decided to cover all types of subgrades with tar paper. Tests made in California indicate that lower strengths are secured when concrete is laid on a tar-paper-lined subgrade than when it is placed on a properly dampened sandy loam subgrade. That being the case, it seems wise to confine its use to those subgrades which cannot be properly dampened.

Constructed fills are now generally saturated to assure settlement before concrete is placed upon them. Where settlement is feared, concrete pavement is now built with sections of 2-in. pipe embedded vertically in it, through which mud is pumped to jack up settled slabs.

Materials and mixes

Although the practice has not yet become universal, the trend is definitely toward the separation of coarse aggregate into two or sometimes even three sizes to prevent segregation and insure proper grading. There are many places where such separation does not add to the cost of the pavement except for the small additional amount of labor needed in batching. When that is the case, the practice seems unquestionably wise. But when it does add materially to the cost, other methods of preventing segregation and insuring proper grading may prove cheaper. The two sizes of aggregate commonly used are that retained on a ¼-in. and passing a 1-in. sieve and that retained on a 1-in. and passing a 2½-in. sieve.

In Kansas and Nebraska, as well as to some extent in western Iowa, small coarse gravel aggregate (maximum ⅜ in) is all that is economically available. By using approximately seven sacks of cement per cubic yard of concrete, both compressive and flexural strengths are secured that compare favorably with those of concrete made with aggregates of normal size. It has been found, however, that a joint spacing of 20 ft. is necessary to control transverse cracking of these sand-gravel concretes.

There has been a tendency recently to use mixes containing a greater proportion of coarse aggregate than had previously been considered desirable. Apparently this is caused by the increase in the early strength of concrete resulting from the fine grinding of cement. Even engineers engaged in trying such lean mixes point out that strength is by no means the only thing to be considered. Durability is even more important, and durability will not be secured if too lean mixes are used. It is fairly well established that pavement concrete is durable when it contains six sacks of cement per cubic yard and not more than 6 gal. of water per sack of cement. Leaner or wetter mixes should be adopted only for experimental pavements.

Tests are being made to determine the relative value of the sodium sulphate tests and actual freezing and thawing for determining durability of aggregates. The best method of making the freezing and thawing tests is also under investigation.

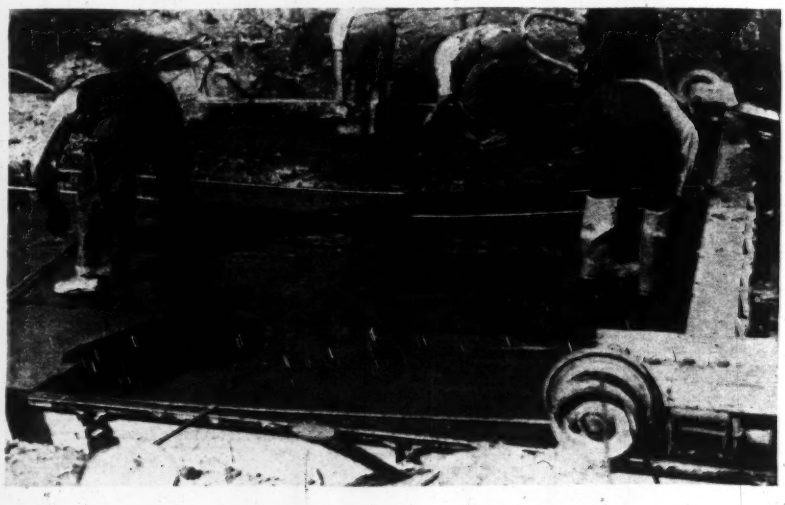
Proportioning plants

Materials are now almost universally batched in overhead bins. The tunnel which was partly underground and partly above ground has practically disappeared from the central proportioning plant, as has that type of equipment which loads the batch boxes directly from the storage pile. A few states where short lengths of pavement are contracted for still allow aggregates to be deposited at about 1,000-ft. intervals along the right-of-way.

Batcher bins are of several types, but nearly all are factory-made and equipped with scales on which each batch is weighed. The home-made batcher bin has practically disappeared from the

Two concrete mixers (above), working abreast, pave 20-ft. width of slab.

Tar paper (below) protects loess subgrades from water in concrete.



modern paving job. In spite of time studies indicating the economy of bins so placed that trucks can drive forward beneath them to get their load, most contractors lay out their plant so that trucks must back under the bins to be loaded.

The proportioning plant usually consists of one, two or three batcher bins set in line along a siding and at such distance from the track that an industrial crane can take materials from the gondolas and put them directly into the bin. Enough space is left between the bins to provide for aggregate storage piles. If bulk cement is being used and is handled mechanically, another overhead bin is required. If the bulk cement is batched by hand, the loading platform may be at some distance from the aggregate bin to provide ample storage space for box cars loaded with cement.

Sacked cement is usually carried to the mixer on top of the aggregate and is not dumped until the mixer is reached. Consequently the loading platform is located so that trucks loaded with batches of sand and coarse aggregate will pass it on the way to the mixer.

The same plant layout and the same type of overhead bin is used for industrial railway haul. The principal difference is in the cement-loading platform. Where sacked cement is used, a platform as long as the length of an industrial train is usually provided so that piles containing the proper number of sacks may be placed along the platform in anticipation of a train's arrival. The industrial railway track is usually placed so that empty trains can run past the plant on a siding and then pull beneath the bins on the main line.

For the past three years all the cement used in Minnesota and Iowa highways was shipped in bulk. Bulk cement is also being used on 75 per cent of the state road work in Nebraska, Oklahoma and Wisconsin, and on many of the jobs in Kansas, Ohio, Illinois, Michigan and Pennsylvania. The advantages claimed for it are lower first cost, greater convenience, lower handling cost and the elimination of sack loss and the labor of cleaning, counting and baling empty sacks as well as the freight on returned sacks. There is also the possibility of charging the mixer to the limit of its capacity when bulk cement is used. This is not always possible with sacked cement because the specifications usually require that only full sacks of cement be used.

There are two general methods of handling bulk cement. One is by hand, the other with some type of mechanical equipment. With hand methods, the cement is shoveled into two-wheeled barrows which are run right into the car. The loaded barrows are wheeled onto a platform scale, where they are weighed, and are then either dumped directly into the waiting truck or into a hopper, where the cement is held until the truck arrives. The total cost of batching bulk cement by hand is about 5c. to 5½c. per barrel, including the cost of the platform and equipment.

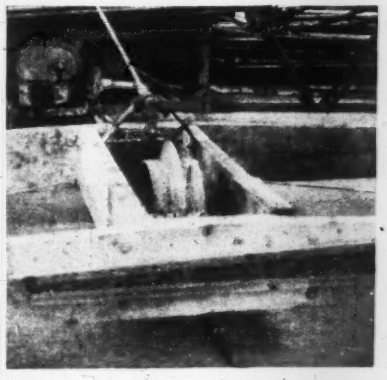
When cement is handled mechanically, it is lifted to an overhead bin by a bucket elevator or is pumped through a pipe. When the bucket elevator is used, the cement is pulled from the car to a pit beside the track by a scraper powered with an automatic winch. If the cement is pumped, it may be pulled from the car in this same manner or the pump may be portable and be taken directly into the car, where it picks up the cement.

The weight measurement of batches of aggregate is now almost universal for highway work. The weighing hoppers are boxes beneath the storage bins and are hung on levers of a scale. In some installations the dial type of scale is used, but in the great majority of cases the scale is of the beam-and-lever type. The fine and coarse aggregates are weighed separately, usually but not always in separate hoppers.

The chief advantage of weight measurement is greater accuracy. It eliminates the variations caused by the bulking of moist sand and by differences in the compaction of the aggregates in the measuring hopper. When aggregates are measured by weight, the quantity of moisture they contain must be known so that the weight of the batch may be adjusted to include the desired weight of aggregates plus the weight of contained moisture.

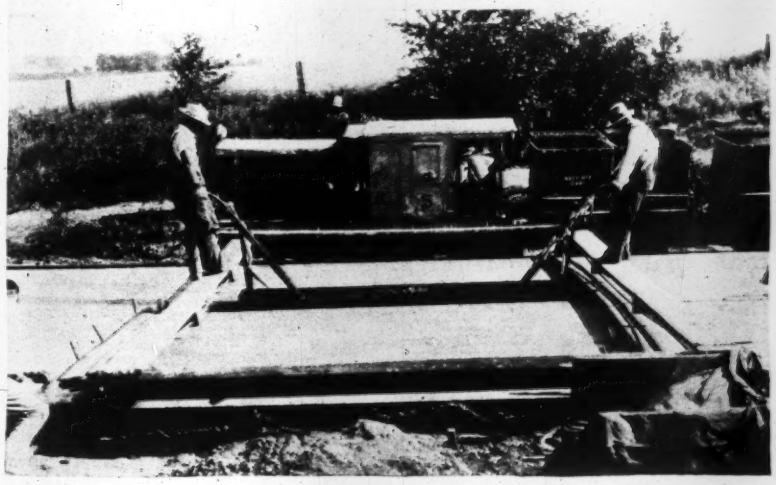
The use of weighing equipment for batching aggregates has led to specifications in which the proportions are given in pounds of cement to pounds of fine and coarse aggregate. Where all the available materials in a locality have about the same weight, such a specification need contain only one proportion, but where there is a considerable variation in weight, the proportion for each aggregate must be included in the

Mixers hitched tandem reduce the time required per batch to 50 seconds.



Wheel pulled behind a finisher cuts the groove for a center joint.

Longitudinal float eliminates any ridges left by other finishing operations and removes excess water.



Laitance and excess mortar are scraped from the surface by a straight-edge.

specification. That has led to the use of specifications in which the weight is varied with variations in the specific gravity of the aggregate or one in which the proportions are stated by absolute volume.

Mixer practice

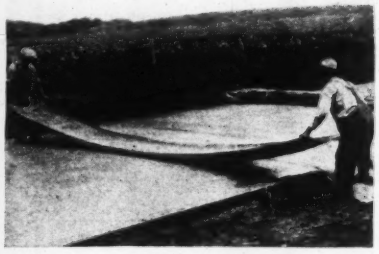
Paving mixers remain much the same as in recent years. The chief changes are improvements in the measurement of mixing water, increased speed of mixer drum, standardization on the 27-E size, and automatic control. This latter feature has enabled the mixer to turn out several more batches per hour than was formerly possible.

A few contractors have increased the production of concrete per crew by hitching two mixers in tandem and allowing each to mix the batch for one-half of the mixing period. With such an arrangement the materials are first placed in the leading mixer, where they are mixed for 30 to 34 seconds. They are then dumped into the skip of the following mixer and raised to the mixer drum, where they are turned for the remainder of the mixing period. With such an outfit the accepted minimum of 75 seconds per batch is cut to 50 seconds with only a slight addition in the number of men required to haul materials and place and finish the concrete. Such an arrangement is definitely prohibited in at least one state.

Joint construction

The use of joints has changed considerably in the past few years. The trend is toward expansion joints at regular intervals. Even those states that have never used such joints now seem to favor them. There is also an evident preference for expansion joints spaced at rather wide intervals with one or more contraction joints between them to control transverse cracking. Contraction joints are usually of the dummy type, made by impressing a groove 2 or 2½ in. deep and about ¼ in. wide in the surface of the pavement. This groove may be made by a machine especially constructed for the purpose or it may be made by pressing into the concrete the web of a T-bar.

Longitudinal joints are now used to divide all pavements wider than 15 ft. Pavements wider than 30 ft. are divided into strips 10 to 15 ft. wide by more than one longitudinal joint. Where there are to be several traffic lanes the longitudinal joints are placed 9 or 10 ft. apart and located so that they form the boundary of the traffic lanes.



Placing burlap for preliminary curing.

Finishing and curing

Finishing has changed little in the past several years. The finishing machine without a tamping templet is now almost universally used on road jobs and machine finishing is gradually becoming more popular for city streets. The once-popular roller is now almost obsolete. A long stiff float held parallel to the side forms and operated from two bridges has proved a very useful piece of finishing equipment, and its use is required by many state highway departments. In Northern states water and laitance are scraped from the surface with a straight-edge as protection against scaling. A final finish given by dragging a strip of burlap over the completed slab has supplanted the older type of belt finish in many localities. Brooming is practiced by several Eastern states and one Western state, but there seems to be no tendency to adopt it in other places except in airports, where it is used because it aids in the illumination of runways.

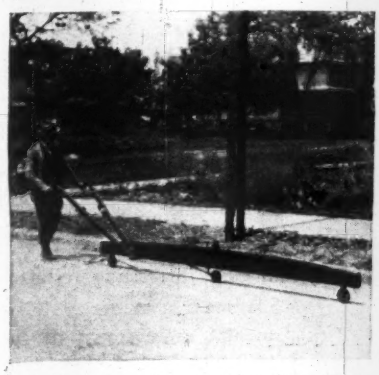
The accuracy demanded of contractors engaged in state highway work is so great that only ⅛ in. inequality is permitted in 10 ft. Although such accuracy at first seemed impossible, contractors have had little difficulty in meeting this specification. Several jobs have been reported where pavements had less than 5 in. of total inequalities per mile.

Sentiment is swinging back toward a preference for water curing. For several years the tendency was to try to cure concrete by some other means, either to reduce the cost of curing or to eliminate some of the objections to water curing. Experience and recent tests, however, have reaffirmed the superiority of water curing, and engineers have been quick to apply the results of the tests. The tendency is toward a shorter curing period. In the Tennessee tests curing for 72 hours with wet burlap gave concrete of practically as great strength as any type of curing. As a result it is reported that the U. S. Bureau of Public Roads now recognizes 72 hours of burlap curing as a standard practice, and it will undoubtedly be used more in the future. At least one state requires curing with straw, believing that to be superior to other water curing methods.

Crews, outputs and costs

In these days of keen competition and low prices a smooth-working organization is essential if reasonable profits are to be secured. The day is long past when a superintendent could get work done by shouting alone; a stop-

Pumping mud under settled concrete slabs to jack them up to proper grade.



Surface inequalities indicated by ringing of a bell caused by the middle wheel which is on a pivot riding above or below a line between the other two wheels.

watch and the habit of planning things far in advance are now more useful.

Organization depends upon the size of the job, the location of railway receiving points and the type of unloading and hauling equipment. It usually consists of a crane man and helper, one or two men weighing out materials, from five to eight or nine handling cement, three industrial railway trains of from 12 to 28 cars each with an engine driver and helper for each train or a fleet of trucks whose number depends entirely on the size of trucks and length of haul.

On the subgrade there is at least one roller man, perhaps one or two other men running a large and a small tractor, with a third to operate a blade grader pulled by one of the tractors, and from five to a dozen men trimming the subgrade and cleaning up after the subgrading machine. If the subgrade is a little high, there may be from one to a dozen teams pulling fresnos.

The concreting crew consists of from two to four form-setters, from one to three men aiding in the dumping of materials into the mixer, a mixer man and in some localities a helper, from four to six or seven men behind the mixer spreading the concrete and placing marginal bars or other reinforcement, from two to four finishers besides a man on the finishing machine, two men placing strips of burlap on the newly finished concrete, and a crew of from two to a dozen or more removing forms and applying whatever curing method is in use. There will also usually be two or three handy men engaged in oiling forms, changing the hose which connects the mixer to the water line and doing similar odd part-time jobs.

If materials are hauled by truck, there will be a repair man, and if by industrial railway, there will be a repair man and a small crew which keeps the track in shape. The water pipe line requires the attention of one or two men who may also service the pump. A foreman for the subgrading crew, another at the mixer, a superintendent and a timekeeper usually complete the organization. The number of men in the entire crew ranges upward from 50, the actual number depending upon the size of the mixer, the type of hauling equipment, the method of curing and the locality.

A batch in 75 seconds and 48 batches an hour continue to be recognized as the best possible production. There is an ever-increasing number of contractors that are closely approaching this ideal production. Although no accurate figures are available, it is believed that the average daily run has increased from the 300 lin.ft. of 18-ft. pavement a few years ago, to from 700 to 1,000 ft. in an average day. At least three paving outfits operating single mixers have laid more than half a mile of pavement in a single day's run. One contractor, operating continuously for 36½ hours, made a non-stop record of 3,700 lin.ft. of pavement during 1931.

There is a growing tendency to require that the contractor provide for continuous traffic on the highway that is being paved. This is especially true in the Northeastern states, where the roads are frequently mountainous and alternate routes are scarce. That usually means the road must be built half at a time, with traffic using the half not under construction. Engineers are not agreed concerning the cost of this half-at-a-time construction, some of them claiming that it is cheaper than building full-width pavement because the contractor is able to haul materials for the second half over the completed first half and thereby reduce his hauling costs. Other engineers believe that the cost is increased by half-at-a-time construction.

During 1931 the cost of concrete pavement was the lowest that has ever been reported for state highway work. Several pavements having a 9-6-9-in. or better cross-section have been built for less than $1 a square yard, while many jobs have gone for only a little more. It is estimated that 1931 paving prices were one-fifth lower than the price of similar pavement in 1929. This is due to the abnormally low cost of the materials going into the pavement and to the reduced charge for labor. It is a condition that cannot be expected to last.

Pavement Edge Profile for Transitions

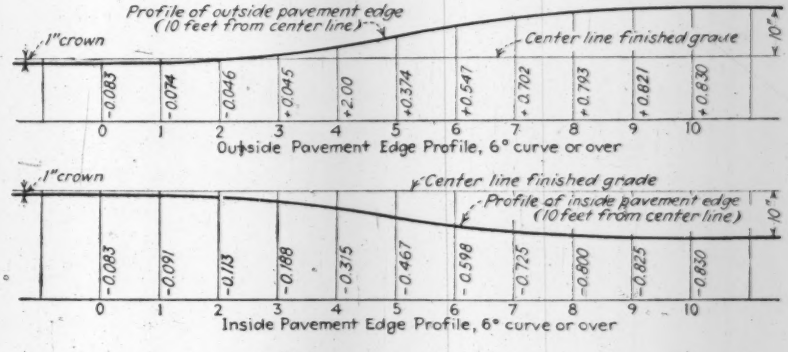
By Oscar V. Hanson

Chief Draftsman, New Hampshire Highway Development, Concord, N. H.

THE accompanying drawing shows a pavement edge profile used for transitions so that the pavement edge will follow reverse vertical while approaching the maximum superelevation. The transition is divided into ten equal parts, and each one of these points has a drop or rise given for the outside edge of the pavement and a drop for the inside edge of the pavement. These are given in hundredths of feet so they can be readily added to or subtracted from the centerline finished grade to give the finished grade at the pavement edges. These rises and drops are not in direct proportion to their distance along the transition, but are so calculated that the profile at the pavement edges will follow reverse vertical curves meeting the pavement edges tangent at either end of the transition. In this way we have a standard pavement edge profile (in relation to the finished grade) for each degree of curve.

The profile for the outside pavement edge differs from that at the inside because on account of the crown in the pavement the outer edge rises more than the inside edge drops. By using this system the crown automatically decreases in direct proportion to the distance along the transition. The rises and drops for each degree of curve are made into a table attached to each set of plans. We also show the rise and drop on each cross-section of the plan. This table is figured for 100-ft. transitions and for 20-ft. pavements, but it can be used for any length or width by dividing the required transition into ten equal parts. This table enables us to plot our sections to agree with the finals, with easier plotting and staking than the proportional parts system, and it makes a better riding transition.

Standard pavement edge profile for transitions.



Advances in Constructing Bituminous Surfaces

Multiplied ways of using bituminous materials indicate opportunities for improving equipment and for mechanizing road-surfacing processes

By Prevost Hubbard
Chemical Engineer, Asphalt Institute, New York, N. Y.

INCREASE in their variety and number has greatly extended the use of bituminous products for road surfacing. At the same time methods of application have been improved by the greater use of mechanical equipment. Invention is active in the further development of equipment, and particularly of trains of traveling equipment for producing road-mix surfaces in a continuous process from the windrow stockpile of aggregate on the subgrade to the spread surface ready to be consolidated by traffic or rolling. In the article that follows these developments are epitomized and appraised by a writer who has been a close student and an active practical worker for years in the field of bituminous road construction. —EDITOR.

RECENT experience in the surface treatment with bituminous materials of silt roads in Missouri and in similar treatment of clay roads, prior to the application of a thin coat of gravel, in Minnesota and neighboring states has demonstrated that such materials, properly used, are effective both in reducing the rise of capillary moisture in subgrades and in preventing absorption of excess moisture from the surface, which would create a soft base.

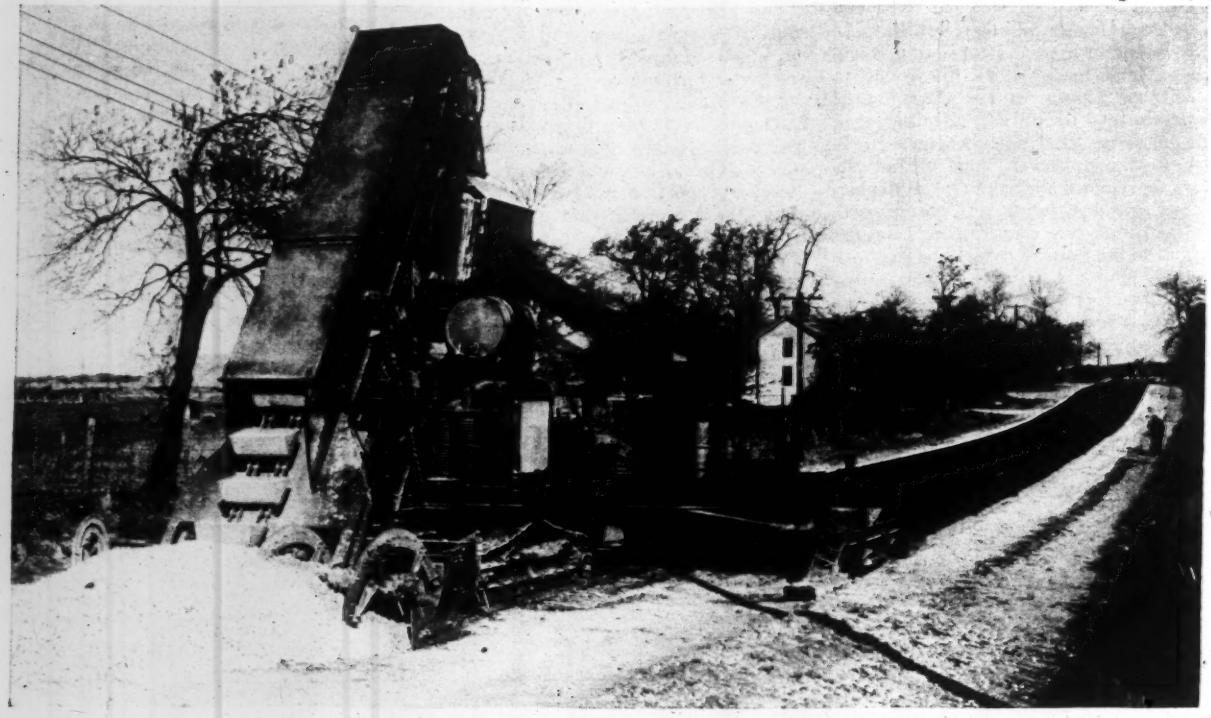
It is believed that thoroughly priming compacted subgrades with liquid bituminous materials prior to construction of any type of wearing course on pavement will eventually become recognized as good practice when dealing with high-moisture-absorbing soils. Such treatment seals the capillary pores and if made on a dry subgrade, trapped air in the underlying capillary channels will greatly retard the rise of capillary moisture.

Laboratory investigations have indicated that an even more effective method which might be fully justified in many cases consists in placing a continuous bituminous membrane at a substantial depth below the final surface of the subgrade. Such treatment insures that if the air trapped below the treatment eventually escapes, rise of capillary moisture past the membrane is absolutely prevented so that the overlying soil is always maintained at its maximum load-supporting capacity. Of course such treatment, except in the case of fills, would necessitate the removal and replacement of a layer of subgrade material, but it is believed that the cost of such operation, including the bituminous treatment, would in many cases be small in comparison with the saving effected by use of a less thickness of the much more expensive overlying road structure. The use of this procedure in actual construction work should yield interesting results.

Surface treatments

A fundamental requirement of successful surface treatment which cannot be emphasized too strongly is that for original treatment of all absorptive road surfaces a bituminous primer should be used that will penetrate the surface for an appreciable depth. This is equally true of earth, sand-clay, gravel and macadam roads. A very fluid product of high penetrating value is required for priming.

Until recently tars were most commonly used for this purpose, but during the past two years an asphaltic primer has been developed that is particularly well adapted for the purpose. Unlike the usual asphalt cut-back containing a highly volatile solvent, which deposits all of its asphalt in a thin film over the surface but does not penetrate, this new product is readily and completely absorbed and deposits an asphalt cement in that part of the road just below the surface. The primed surface is thus put in proper condition to receive a second bituminous treatment with a heavier mat-building material or to be covered with any desired type of bituminous wearing course that may be selected.



Road mix plant laying bituminous surface as it moves along.

For bituminous surface treatments it is highly desirable that heavy distributors be equipped with pneumatic tires. In the construction of bituminous mats or carpet coats, it is also desirable that the cover material be evenly applied by mechanical chip spreaders and that a broom drag be used thoroughly to coat the surface dressing of mineral aggregate with bituminous material. When the broom drag is to be used the cover aggregate should preferably be spread before the bituminous material is applied.

Road-mix types

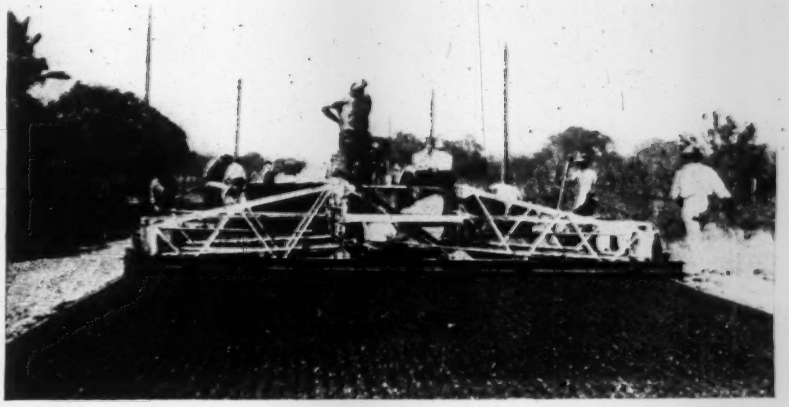
The construction of bituminous surfaces by mixing selected aggregates with liquid bituminous binders directly in place on the road has been one of the outstanding developments of modern highway practice in the building of low-cost roads. There are two well-defined classes of road mixtures, known as the graded-aggregate type and the macadam-aggregate type. This difference in character of mineral aggregate makes it necessary to use bituminous products with distinctly different properties for the two types of road mixtures and also involves certain differences in methods of construction.

For the graded aggregate type it is necessary to employ a slow-curing bituminous material which produces a mixture that is most advantageously compacted by traffic, accompanied by blading. The macadam-aggregate type of mixture is, however, produced with a rapid curing cut-back material and is consolidated by rolling shortly after mixing. Both types of mixtures are produced rapidly in large quantities and the use of trailer supply tanks for transporting bituminous material from the railway siding to the job not only expedites the work but greatly increases the capacity of the distributor for applying material and reduces haulage costs.

Although the ordinary road blader can be used for mixing, a number of much more efficient blading and finishing devices are now coming into use. Nearly all of these are a form of long-wheelbase drag, with multiple blades designed to turn the aggregate a number of times with each pass of the machine. The blades and strike-offs are usually adjustable and can be raised or lowered as required. Some of the drags run on wheels, while others are mounted on long shoes. A crawler tractor without cleats is the preferred method of moving the drag mixers.

Machine-mixed low-cost roads

For the graded-aggregate type of low-cost road mixture, in which correct proportioning within comparatively narrow limits is essential, plant mixing has many advantages. Use of the customary hot-mix plant for such mixtures is expensive unless the plant is set up at pit or quarry and is operated continously to produce mixtures that can be economically transported to the road. Where all or a part of the aggregate is obtained from the old road which is to be resurfaced or from a number of local deposits, road-mixing plants have certain advantages.



Spreading and finishing machine for hot-mix bituminous pavements

Several ingenious and practical road-mixing plants have recently been developed which not only proportion and mix satisfactory but perform other operations as well, such as picking up the aggregate, from windrows along the road, mixing and discharging continuously and depositing, screeding and tamping the finished mixture whle moving ahead.

It is believed that plant mixing in some form will eventually supplant road mixing for the graded-aggregate type of low-cost mix, especially if some method of cheaply drying a wet aggregate, prior to mixing, is devised. Plant mixing permits the use of a much more viscous bituminous material than does blade mixing, and this is highly desirable.

Penetration types

In bituminous-macadam construction the most outstanding improvement in recent work has been the elimination of the heavy rich mat seal coat and the production of a waterproof, tightly bonded but rough texture mosaic surface, in which the large stones take all of the wear of traffic and provide a sure and safe grip for vehicle wheels. Such construction has reached a high degree of perfection in Massachusetts.

The use of liquid bituminous materials such as cut-back and emulsified asphalts in the construction of penetration types of wearing courses has also produced excellent results when the void size of the aggregate has been properly controlled. For such products the one-size commercial crushed stone, such as used with a preheated bituminous binder, is too coarse and should be graded down to contain fragments as small as ½ in. in diameter.

Use of pressure distributors equipped with pneumatic tires or offset spray bars should be encouraged for all pentration construction.

Hot-mix types

The most important recent development in connection with the construction of hot mix pavements is undoubtedly the use of machines for spreading, raking and partly compacting the hot mixture. There is no question that machine finishing produces a much smoother riding surface than is now being produced in the great majority of hand-spread and hand-raked pavements, and the sooner machine finishing is generaly adopted the better it will be for the bituminous paving industry. There is no valid reason why the riding qualities of a newly constructed bituminous pavement should be inferior to the best obtainable in any type. In addition to machine finshing, more general use of the heavy three-wheel roller for initial rolling compaction is an aid to securing permanently smooth riding qualities.

In connection with mixing plants for both hot and cold laid mixtures, it appears probable that the next few years will witness notable progress in the development of satisfactory rotary mixers. With this development the use of transit mixers in bituminous pavement construction may even be expected.

The average paving plant in present use is usually susceptible to considerable improvement from the standpoint of efficiency of operation and uniformity of output. As different plants vary considerably and many are excellent in some respects while deficient in others, the following items of what might be considered as approaching the ideal in equipment deserve special mention as applying to larger capacity plants.

The steam boiler might well be eliminated and replaced with a power unit consisting of a generator operated directly by a diesel engine with direct motor drive for all moving parts, which should be equipped with grease-packed roller bearings. The proportioning and feeding of aggregates from the stock bins to the drier should be performed by

automatic belt conveyors. The drier should be internally fired by low-pressure air burners using heavy preheated fuel oil and the oil feed should be thermostatically controlled. A dust collector should be connected with the exhaust from the drier and should discharge into a dust bin, forming part of a ball-mill air classifier unit for producing mineral filler from crushed rock or sand. Aggregate from the drier should pass through a vibrating screen and be discharged into circular storage bins which will reduce segregation to a minimum. Scales for weighing aggregate should be equipped with automatic cut-off on the feed to the weighing box.

Asphalt should be delivered in insulated tank cars and run into an insulated storage and heating tank, equipped with a hot-oil circulating coil in the heating chamber. A circulating pump feed through insulated pipe should discharge into the weighing bucket, which should be oil jacketed and equipped with a sliding gate discharge in the bottom. Mineral filler should be weighed on a separate scale with automatic cut-off and should be fed from the bin hopper to the scale by a screw conveyor.

For the pug-mill mixer a dust hood should be provided and the mixer itself should be heated by a hot-oil circulating jacket. The mixer should also be equipped with an adjustable timing control device, and the blades should preferably be set to force the mixture in a horizontal rotary path around the inside of the mixer rather than to toss it from the ends to the center.

Other types of bituminous surfaces

Cold-laid premixed bituminous pavements are undoubtedly gaining in popularity and promise to occupy an important part in future highway work. Many of them are now being laid under patents covering their composition or method of preparation. At the time of laying, the bituminous binder must be of softer or more fluid consistency than for the hot-laid mixtures and for this reason best results are most likely to be obtained where the mineral aggregate contains a sufficient percentage of coarse fragments to produce high stability in the compacted mixture, irrespective of the bituminous binder.

In connection with the construction of asphalt-block wearing courses, the most recent development is the use of a liquid asphaltic joint filler which thoroughly waterproofs the joints and slightly tempers the upper surface of the block.

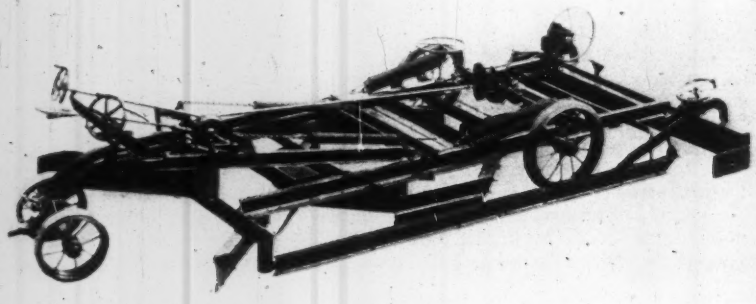
A comparatively new type of bituminous surface in the form of asphalt plank has been in use for a sufficient length of time to demonstrate its serviceability for certain classes of highway work, particularly in the paving of bridge floors where weight is an important consideration. Asphalt plank consist of a compressed mixture of roofing felt and similar organic material with finely devided mineral matter and asphalt cement.

Progressive stage construction

There are so many types of bituminous surfaces to select from that with a little thought the engineer can select a form of construction best suited to meet the conditions of present traffic on a given project at the lowest possible cost. One of the outstanding advantages in first selecting a low-cost type of asphalt construction is that as traffic demands become more severe and a higher type is required, the one first used can almost invariably be salvaged and in so doing the cost of new construction is kept to a minimum.

This feature is being appreciated more and more by the engineering professon as the necessity for spreading the highway dollar to the maximum justifiable limit becomes more pressing. Thus, a surface-treated earth road makes a much better subgrade for new construction than does an untreated earth road. When traffic becomes more severe, it can be used as a support for a thinner road-mix gravel or macadam surface than would be the case had it not been treated with bituminous material. In turn, the road-mix type, after maintenance by surface treatment, will eventually serve as a substantial base for a higher type of wearing course, such as bituminous macadam, which in turn, as traffic becomes more severe, can be covered wth a hot-mix type of construction. At all stages of such a systematic development, the previous investment in the road is conserved to the maximum extent and new construction becomes relatively inexpensive, which is not true in frequent cases where an old road is completely replaced by a high-cost type as an independent unit of construction.

Multiple blade machine for mixed-in-place bituminous surface.



Gasoline Taxes in 1931

THE 1931 total collection of gasoline taxes is expected to be in the neighborhood of $525,000,000, passing the half billion mark for the first time and exceeding by almost $200,000,000 the receipts from license fees according to preliminary figures of the National Automobile Chamber of Commerce.

Every state legislature meeting in 1931 had before it the question of gasoline taxation. Many of the rates were advanced, some for highways, some for general treasury use.

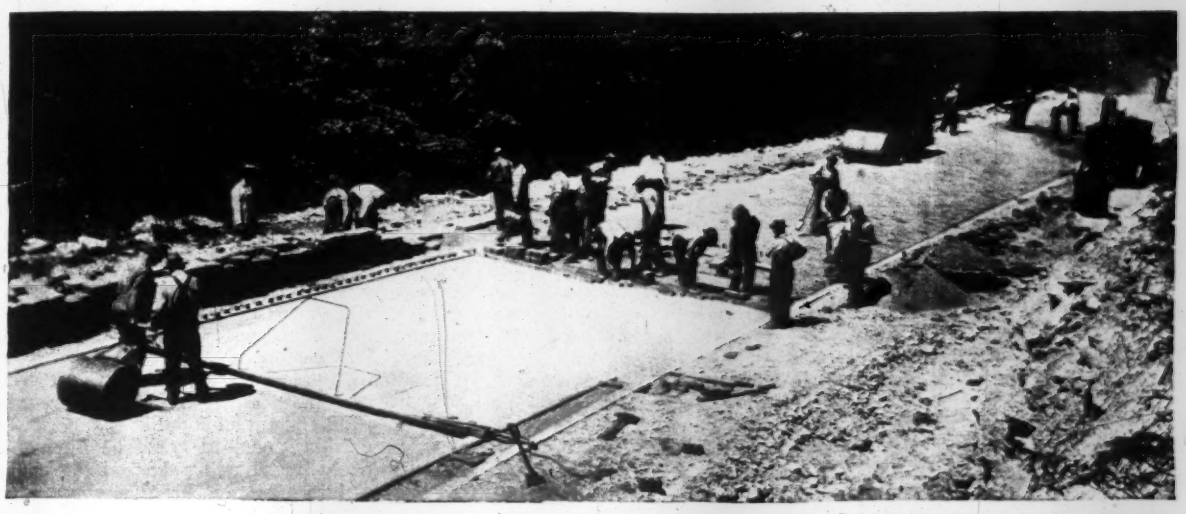
Ten states made an increase of 1c. per gallon, two states obtained 2c. more; while two states tacked on half a cent additional. Two states—Florida and Tennessee—raised the total tax to 7c. Four states now boast a 6c. rate, one a 5½c. rate; ten are in the nickel class; sixteen collect 4c. per gallon, eleven take 3c., while the remaining four and the District of Columbia are still satisfied with 2c. Missouri may soon be the only state in the latter classification, bound by constitutional amendment not to raise the 2c. rate before 1938.

Other legislatures have eased their consciences by making promises of future reductions. Oklahoma's 5c. rate reverted to 4c. on Dec. 31 of last year; Arizona intends to maintain a 5c. rate until Jan. 1, 1933, when it reverts to 4c. Massachusetts, now collecting a 3c. tax, will act on a referendum in September, 1932, which calls for a 5c. tax. Whatever the rate after that date, it is to run until April 30, 1933, and then drop back to 2c. Montana looks ahead ten years to March 31, 1941, when the 5c. tax is to be reduced to 3c.

A check between the U. S. Bureau of Mines figures on indicated total gasoline consumption in the preceding year of 1930 and the U. S. Bureau of Public Roads figures on gasoline taxes indicate that only a small portion of the total escaped taxation in that year. This is assuming that 90 per cent of all gasoline consumed is used in motor vehicles.

About 95 per cent of the gasoline tax money is used on state and county roads, for the servicing of state and county bond issues, or for city streets.

The tendency to divert gas-tax money from road funds to general funds and to specific uses such as schools and state institutions showed increased strength in 1931. There were also larger appropriations of motor-vehicle tax money for city street improvements. Impulse to these diversions and to wider distribution was given by the poor financial condition in which some states and many counties and cities found themselves as the result of the general depression.



Brick paving scene showing all operations from cushion laying to joint filling of completed pavement.

Technical Advances in Brick Paving Practice

Improvements in base, cushion, brick and filler being welded into smoother and more stable road surfaces by precision methods of construction

By G. F. Schlesinger

Chief Engineer and Managing Director, National Paving Brick Association, Washington, D. C.

THE INTENSIVE STUDY being devoted to brick pavement construction is the outstanding feature of the recent practice in the use of this very old method of road surfacing. The base, the bedding course, the joint filler and even the brick itself have been subjected to technical analysis and simplification processes which rank high among the technical advances in road-building. This article, by the engineer of the National Paving Brick Association and a roadbuilder of wide experience, is a remarkably complete summary of the latest practice and opinion that have resulted from this extensive study. —EDITOR.

A BRICK pavement is essentially premanufactured. Its construction consists of assembling finished units that are produced at permanent plants. It thus differs fundamentally from pavements that are produced or processed at or near the site of the work. The manufacturing process of converting natural deposits of shales and clays into vitrified paving brick is largely mechanical. There is probably some field for development in production methods, as is true of most manufacturing processes. The paving operations require a relatively small investment in equipment and machinery; any decided change in this respect cannot be economically justified. But properly to construct a brick pavement requires a high degree of manual skill and precise workmanship.

Recent development in the construction technique for each of the elements of brick pavement structure are discussed in this article.

Base course practice

Brick pavements have been laid on various types of base courses with satisfactory results, but the base for the great majority of heavy-traffic pavements is concrete. Concrete base construction alone is considered in this article.

In most instances plain concrete has been used, although in several localities steel reinforcing is included. There is some difference of opinion among engineers whether a concrete rich in cement content should be used or one that is lean. Judged by existing practice, especially among municipal engineers, a concrete of lower cement content than for concrete pavement is favored. The arguments are that such a concrete will expand and contract less with changes of temperature and moisture. Also, as its tensile strength is less, cracks that form, although more numerous, are much finer, have greater resistance to load stresses and will not affect the surface.

Many engineers, in the case of bad subgrade conditions, favor a richer concrete mix for the base course and the use of reinforcing. The trend seems to be to use a richer concrete for base courses on state highway construction than in municipal work. This may be due to the belief that in municipalities there are more thorough drainage and satisfactory subgrade conditions.

In several brick projects, constructed within the last few years, a concrete base has been designed with the idea of prelocation and control of joints and contraction cracks. Expansion joints have been placed at definite intervals and planes of weakness or contraction joints at shorter intervals between expansion joints. In several projects the expansion joints have been partly filled with bituminous material prior to laying the brick. This is designed to avoid displacement of the bedding course. Crack-controlled concrete bases have been constructed recently in Summit and Stark counties, Ohio, by the Ohio state highway department and in Niagara County, N. Y. It would seem that the metal air cushion type of expansion joint would be well adapted for concrete base-course design, although there is no record of its having been used.

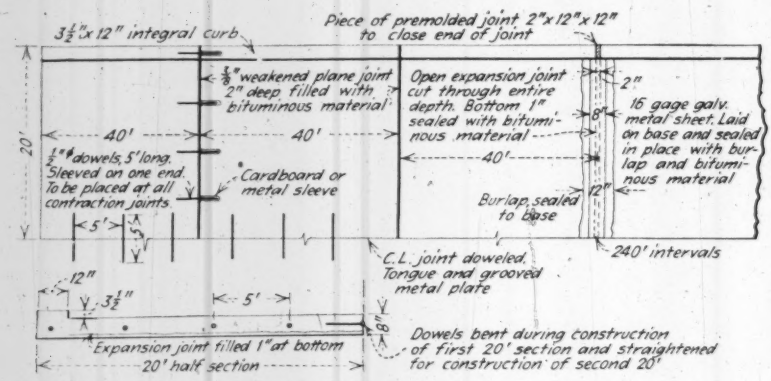
It is prevailing practice to use a concrete base course of considerably less thickness under a vitrified brick top course than for a single pavement slab. Many engineers also decrease the thickness of base course for a brick pavement as compared with other types of surfacing of less depth.

The smoothness requirements for surface finish of base courses of all kinds in modern specifications is practically the same as for the surface of a pavement; ¼ in. in 10 ft. is a common specification. As in the case of concrete paving slabs, subgrade and finishing machines have been a major factor in securing concrete base courses of specified cross-section and contour. Standard specifications in general require their use for base courses of brick pavements.

Bedding course practice

When it was the practice to construct base courses with an irregular and

rough finish, the bedding course was used to take out the inequalities and provide a smooth surface on which to lay the brick. There was always considerable variation in depth, which often resulted in a shifting of the cushion, with subsequent effect on the brick surface course. A present-day brick pavement is designed with a much thinner cushion course than that used formerly and it is of uniform thickness. This is possible because modern specifications require the base course to be finished practically as smooth as the surface of the road. The bedding course should not be thicker than 1 in. and, preferably, not thicker than ¾ in.


3½"x 12" integral curb
Piece of premolded joint 2"x12"x12" to close end of joint
⅜" weakened plane joint 2" deep filled with bituminous material
Open expansion joint cut through entire depth. Bottom 1" sealed with bituminous material
2"
8"
16 gage galv. metal sheet. Laid on base and sealed in place with burlap and bituminous material
40'
40'
40'
20'
½" dowels, 5' long. Sleeved on one end. To be placed at all contraction joints
Cardboard or metal sleeve
Burlap sealed to base
12"
5'
C.L. joint doweled. Tongue and grooved metal plate
240' intervals
12"
3½"
5'
Dowels bent during construction of first 20' section and straightened for construction of second 20'
Expansion joint filled 1" at bottom
20' half section

Expansion and weakened-plane joints in concrete base for brick pavement.

The bedding material used most frequently is sand that passes a ¼-in. screen. In most specifications there is no gradation requirement and loam up to 10 per cent is permitted. However, there seems to be a trend toward the requirement of a coarser and cleaner sand, and the Ohio state highway department specifications provide that not less than 60 per cent shall be retained on a No. 20 sieve and limit the loam content to 3 per cent.

In localities where granulated slag can be obtained economically, this material will make an excellent bed. Stone and slag screenings have been used successfully also. These last-named materials have considerable cementing properties which prevent the tendency to shift. Experiments conducted by the U. S. Bureau of Public Roads indicate that plain sand cushions are preferable to a cement-sand mixture.

A development of recent years is the use of a bituminous-sand-mastic mixture for the bedding course. This type of cushion is required in the latest specifications of the Illinois highway department and was used on the brick resurfacing projects constructed in 1931 in that state. In most cases the mastic was mixed in a small concrete mixer. Other recent projects on which bituminous-mastic cushions have been used are in Olean and Auburn, N. Y. Both tar and asphalt cutbacks have been used for the bituminous materials. In the Illinois work, the tar-sand mixtures were reported to be more easily manipulated, and some difficulty was experienced with the use of cutback asphalt. On the Auburn work, asphalt was used; the mastic was mixed in an asphalt plant and there was no trouble in manipulation. Judging from experience up to date, it is believed that a slow-drying asphalt has better possibilities for mastic cushion than a quick-setting cutback asphalt. A bituminous-mastic cushion would seem to have the advantages of being waterproof and stable and of having considerable ability to bridge over cracks in the base. According to the best information available, it adds about 5c. a square yard to the cost of the brick pavement.

A double templet riding on steel angles laid on the inside of the concrete curb has been used to finish the cushion course. The adjustable head templet strikes off the cushion head and it is then rolled with a long-handled roller; the templet is then pulled ahead and adjusted to the final and correct cross-section. The templets are part of a rigid frame and about 20 ft. apart. The finishing machine could be used effectively for finishing the bedding course, and its adoption for this purpose will undoubtedly follow more extended use of the bituminous mastic bed.

Brick course practice

The depth of brick course in modern design is less than was formerly used. Until comparatively recent years the minimum depth of the brick course was 4 in. and the brick were laid with their longer cross-sectional dimension vertical (on edge). Experiments conducted by the U. S. Bureau of Public Roads on a brick-paved circular track at Arlington demonstrated that, when properly supported, brick down to 2½ in. in depth will withstand heavy traffic. The depth of vitrified brick surface course in most common use is 3 in., although 2½ in. is used to a considerable extent. The brick are now laid with the shortest dimension vertical (flatwise). This has served to secure a more satisfactory riding surface and, because of a less number of brick units required and fewer joints to fill, combined with decreased depth, has resulted in lowering the cost of brick pavements.

The initial simplification project of the U. S. department of commerce, in its effort to eliminate waste in industry, was that inaugurated by the producers of paving brick in 1921. As a result of

Asphalt filler applied direct to pavement from heated pressure distributor.

Asphalt filler applied with wheeled squeegee serviced from truck tank.

the work of the Permanent Committee on Simplification of Variety and Standards for Vitrified Paving Brick, on which the leading engineering organizations are represented, the varieties of paving brick in common use have been reduced from more than 60 to six. These six varieties constitute a great majority of the total shipments, but according to the latest survey, in 1930, the percentage showed a decrease. This is due to the recent introduction of new types of paving brick.

The trend is toward the increased use of a lug type of brick which will insure positive separation of the joints and permit more thorough penetration of the filler. The lug brick has always been used more extensively in the East and, according to recent reports, will be required in certain sections of the West where lugless brick has heretofore been used. A type of lug brick introduced recently that is meeting with much favor is a wire-cut brick (vertical fiber) with lugs. This differs from the old wire-cut brick in having the wire-cut on the surface instead of on the die side. Difficulties in manufacturing this type of brick have been overcome and the wire-cut surface provides an additional non-skid feature. If this type of brick proves satisfactory, it would be possible to standardize on it, which would result in further simplification of varieties. This would contemplate a standard brick with the same surface dimensions, the only variation being in the depth. It has been suggested that three depths (2½ in., 3 in. and 3½ or 4 in.) would answer all purposes. It will take several years before it will be known whether such a development will be the result of the introduction of the wire-cut brick with lugs.

The workmanship on laying brick pavements has been improved materially with the higher requirements of modern brick paving specifications. The Illinois and Pennsylvania highway department specifications require a smoothness of ⅛ in. in 10 ft. There is no reason why a brick pavement should not be built as smooth as any other type, as the surface contour can be readily adjusted during construction and even later, after the pavement is under traffic.

Joint filler practice

The filler now being used in practically all brick paving construction is a bituminous material—in a great majority of cases, straight asphalt. The tar producers have been endeavoring to develop a tar filler that will be practicable and satisfactory, and one experimental section of brick pavement with pitch filler was installed this year at Trenton, N. J. Portland cement grout, formerly used as a filler on all high-grade construction, is still required to some extent for special work, such as street-car tracks, gutters and parking strips. In such cases provision is usually made for expansion. The reason a bituminous or flexible material has been almost universally adopted for filler is that difficulties incident to temperature changes, such as internal stresses and occasional blow-ups, have been obviated by its use. In addition, if properly constructed, the joints are sealed against the entrance of moisture and the edges of the brick protected. A good bituminous filler material should have the following properties:

1. Such penetration at high temperatures that it may be readily applied.
2. Such penetration at freezing temperatures that it will retain sufficient flexibility and will not chip.
3. Ductility and adhesiveness ample to adhere to the sides of the brick and to provide elasticity; at the same time not so great as to retard wearing off the surface under traffic.
4. A softening (melting) point high enough so that the filler will not flow or bleed in hot weather.

When plain wire-cut (vertical fiber) lugless brick were being used more extensively, a number of the engineering authorities adopted an asphalt filler specification which provided for higher penetration with consequent lower melting point and a higher ductility. Because of the difficulty in applying filler with lugless brick, this type of filler seemed to give more satisfactory results so far as construction was concerned. However, it has an objectionable quality of bleeding during extremely hot weather. With the more general use of lug brick, it is believed that a filler with higher softening point and lower penetration will prove to be more satisfactory.

A mastic asphaltic mixture, consisting of about 25 per cent sand or fine mineral aggregate, has been used successfully in New Orleans, La., and Jacksonville, Fla. The aggregate content, of course, increases the stability of the filler, decreases its tendency to bleed

or flow at high temperatures and eliminates slipperiness. Trinidad Lake asphalt, which contains from 25 to 35 per cent mineral, was used this year in Richmond, Va., on a small area. According to reports the results were very good. There are an increasing number of engineers who believe that, with lug brick, a bituminous material with mineral content is the proper answer to the filler question.

Emulsified asphalt has been used in an experimental way in recent years in Ohio. The joints were swept full of a coarse sand and the asphaltic emulsion then applied cold with a truck pressure distributor. It has also been used as a final application with the standard asphalt filler. Insufficient time has elapsed to determine the merits of this material, although it has some points in its favor—notably a lack of slipperiness.

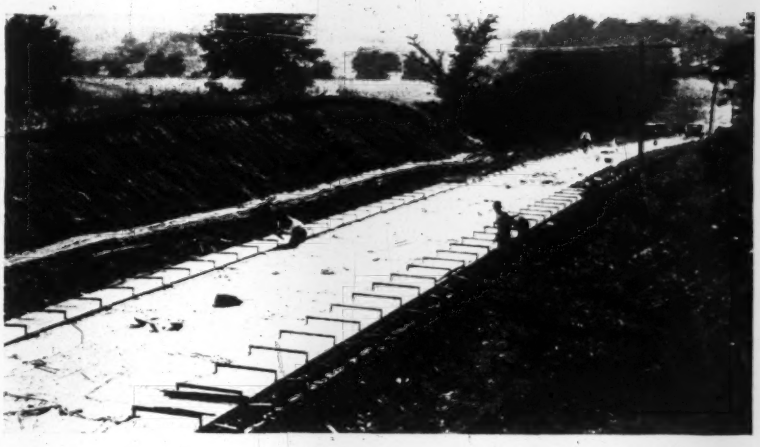
Transportation handling and laying brick

For a majority of projects brick are transported from the plant by rail. There has, however, been a marked increase this year in the relative quantities and distances hauled by motor truck. On an Illinois contract last summer the length of the truck haul was about 100 miles. With truck haul, two handlings of the brick—into and out of the railroad car—are eliminated. In direct-plant haul trucks equipped with demountable bodies have been used. About 1,500 paving brick, piled in a pallet, can be picked up using the truck's power and the loaded pallet set off on the job. It is then necessary to repile the brick for more convenient handling. On one street-paving project, the brick were piled in wooden crates on the railroad siding and then hauled by truck. These crates were of such size that, when unloaded, they could be placed in position for the bricklayers. Side piling was thus eliminated. It is reported that several railroad companies are considering the shipment of brick in truck containers, but there is no knowledge that this method has been used for paving brick.

Gravity roll conveyor carrying brick from roadside piles to the dropper.

The usual means of getting the brick from the side piles to the dropper is a gravity conveyor of rolls. However, some contractors prefer to use brick clamps or pallets, especially for narrow pavement widths. Sporadic attempts have been made to devise and use bricklaying machines. It is believed there is no economic necessity for such a development. The problem is not the same as for brick building construction. Paving brick are laid by semi-skilled labor that has become very proficient in performance. On a contract in Illinois last season the McCarthy Improvement Co., Davenport, Iowa, attained an average of 1,700 lin.ft. of brick surface, 17 ft. wide, per day. About the same time in Niagara County, N. Y., the J. F. McKinney Corp., of Niagara Falls, was averaging 100,000 brick a day during an eleven-day period. One Eugene Wilson, using seven helpers and employed by the Modern Construction Co., Fremont, Ohio, is reported to have dropped an average of 45,000 paving brick per day on a last summer's job. When it is considered that the expense of laying brick is considerably less than 10 per cent of the cost of a brick pavement it is apparent that no great saving could

Brick trucked from car in pallets distributed direct to hands of droppers.



Widening old concrete road for resurfacing with brick.

be effected by the mechanization of the various brick paving operations.

Application of filler

Even with an ideal filler the results will be unsatisfactory if there is poor workmanship in its application. The asphalt filler should be heated to between 350 deg. F. and 390 deg. F. and a thermometer should be required on the heating kettle. The filler should be forced into the joints as soon as possible after it is applied to the surface of the brick. Asphalt that has cooled will congeal and there will be only partial penetration into the joints, which should be completely filled. In addition to this, cool asphalt will spread out over the surface, causing a rough pavement and slippery conditions.

A device that has come into use in recent years has greatly improved the application of asphalt filler. It is known as the wheeled squeegee (or buggy) and consists of a small tank mounted on wheels, with a discharge pipe and curved flexible squeegee attached. The asphalt is discharged direct from the heating tank into the squeegee bucket and its flow onto the pavement is controlled with a valve by the operator. It cools very slowly in the small tank and is raked into the joints immediately after it flows out onto the brick. A number of recent specifications require this method of application.

Another recent development is the use of truck distributors in transporting the filler from the railroad tank cars to the site of the construction. On some projects the asphalt has been applied under pressure direct from the truck distributor and scraped into the joints with hand squeegees. The use of the truck distributor insures that the filler is maintained at the required temperature. In many cases, because of the fact that the application of filler is about the last operation in connection with the construction of a brick pavement, the work is performed during cold weather. This has frequently been the reason for poor results. Modern specifications require that the temperature of the brick be raised to not less than 80 deg. F. immediately before applying the filler, by the use of surface heaters or similar devices when the temperature of the brick is below 50 deg. F. This method is not expensive and will insure satisfactory results.

Modern specifications also stimulate a minimum thickness of the surplus asphalt remaining on top of the brick. This is usually limited to $\frac{1}{32}$ in. It is important that immediately after the joints are filled the brick be covered with dry, clean, coarse (preferably crushed) stone, slag or sand, which should be rolled thoroughly into the thin coating of asphalt while it is still hot. If the air temperature is cool, heating the screenings is recommended. Properly done, this will provide a gritty, non-slippery surface and will facilitate the wearing off of the surplus asphalt under traffic. Another method that has been used to a limited extent is to coat the surface of the brick with a material that will facilitate the removal of the surplus asphalt after the application. Materials that have been used and proposed for this purpose are ordinary whitewash, light oil and sodium silicate.

Resurfacing methods

Many paving authorities are faced with the problem of resurfacing old roads and streets that are beginning to show signs of weakness and deterioration. This resurfacing is usually performed in conjunction with widening, as the old pavements are narrow when judged by modern standards. During the past season the Illinois division of highways used vitrified brick for resurfacing more than 60 miles of worn concrete pavements on the state highway system. The new cross-section provided for a widening to a total over-all width of 20 ft., with a concrete curb which projects under and reinforces the edges of the slab. A majority of the existing concrete pavements that were resurfaced were 18 ft. wide and the remainder 15 or 16 ft. wide. A bituminous mastic cushion is specified with a minimum depth of $\frac{1}{2}$ in. and a maximum of $1\frac{1}{2}$ in. Inequalities greater than $1\frac{1}{2}$ in. are leveled with a cement mortar mixture.

Instead of concrete the use of a metal curb has been proposed, especially when additional widening is not required. A type of metal curb, recently made available commercially, consists of $\frac{1}{4}$x7-in. steel plates with round or flat $\frac{1}{2}$-in. tie rods about 5 ft. on centers. The tie rods rest on the top of the old slab and hold the plate curbs in place. In the case of brick they are covered with the bedding course. A small test section of brick resurfacing with this type of steel curb has been in service for more than a year with excellent results.

Loose-Leaf Field Books Increase Location Survey Accuracy

By Fred Grumm

Engineer of Surveys and Plans, California Department of Public Works, Sacramento, Calif.

THE State of California division of highways has adopted the loose-leaf system for recording location survey notes. The system is more convenient than the bound field books; it makes available to the field office the records taken in the field each day without interfering with information carried into the field; it allows an orderly assembly of consecutive notes on each phase of survey without cross-reference to numerous books, and it reduces the bulk of field-book files.

Efficient procedure during survey and design depends largely upon the office progress of mapping and projection, work which requires access to all the field notes. With the loose-leaf system, data can be given the office immediately and regularly. The locator can review the results as the survey proceeds. Errors or inadequacies can be rectified at once. Work can be coordinated without delays occasioned by not having notes available.

The practice of copying original notes for office use is tedious and costly; copied notes must be checked to be reliable. With the loose-leaf system copies are generally unnecessary, but carbon duplicates can be made as notes are taken, if duplicates are desired. One standard size and ruling of sheets is furnished for all survey work. Duplicate unruled sheets and sized carbon sheets are furnished for making carbon copies. All sheets are perforated and ring binders furnished therefor.

An Estimate of Highway Construction in 1931

Some figures of comparative expenditures, mileages constructed, income from motor vehicles and federal aid, with an appraisal of local road work and future trends

By Charles M. Upham

Engineer-Director, American Road Builders' Association, Washington, D. C.

STATISTICS of highway activity for 1931 are not complete until much longer after the end of the year than this issue is dated. There are no official agencies for recording expenditures and work accomplished other than on the federal-aid and state systems. Any record of money spent and work done on more than two and a half million miles of other highways is the result of voluntary inquiry and reply. The figures given in this article are therefore educated estimates based on the best information and judgment that the author could command through the resources of the association of which he is the managing head. In a broad way they picture fairly the activities and trends of public road work during 1931. —EDITOR.

THE expenditures for state highway construction and maintenance for 1931 are estimated at $964,000,000. They were $980,000,000 in 1930 and $800,000,000 in 1929. The estimated figures for 1932 total $884,000,000. States that have estimated sizable increases for 1931 include Illinois with an increase of $16,000,000, Louisiana $32,000,000, Massachusetts $7,000,000 and Minnesota $7,000,000. The largest decreases noted are in Iowa and Tennessee, the former reporting a decrease of $19,000,000 and the latter $25,000,000.

State estimates are usually conservative and it is probable that the actual 1931 figures will equal or exceed those of 1930 for the 48 states.

Actual contract expenditures by state highway departments for roads and bridges for the first six months of 1931 amounted to $378,000,000, against $332,000,000 for the first six months of 1930, an increase of $46,000,000 for 1931, as reported by the American Association of State Highway Officials. Fifteen states report decreases for the half year; the largest of these decreases include Ohio with $12,000,000, Pennsylvania with $21,000,000 and Tennessee with $8,000,000. Louisiana reported an increase of $35,000,000 and New York an increase of $8,000,000.

Highway construction

The total mileage of highways improved and surfaced by state highway departments amounted to 35,000 miles in 1930; it is estimated to be 40,000 by the various state departments for 1931, an increase of 5,000 miles.

Louisiana estimated a construction program of 3,200 miles, which was the largest figure submitted for 1931. Two thousand miles of this had been contracted by July 1 at a cost of nearly $50,000,000. Included in the total estimated mileage were 1,200 miles of hard surfacing, the remainder consisting of grading, untreated gravel, macadam, asphalt and brick.

Illinois placed under contract highway projects amounting to $15,000,000 in November, 1931, making a record for that state for any one month.

Missouri at the end of 1931 will have completed its biggest roadbuilding year; the state highway department has constructed 2,556 miles.

Pennsylvania is the outstanding state in the East, with a total of approximately 3,000 miles constructed in 1931.

States building more than 1,000 miles of highway in 1931 include Illinois, Iowa, Kansas, Louisiana, Minnesota, Missouri, Montana, Nebraska, North Dakota, Oklahoma, Pennsylvania, Texas and Wyoming. Grading and low-cost surfacing account for the greater portion of the mileage in the states named west of the Mississippi. Its 1,200 miles of hard surfacing places Louisiana in the van for high-type construction for the entire country. Illinois is second with 1,000 miles, New York third with 775 and Texas fourth with 700 miles.

Federal aid

In April, 1930, federal-aid funds were increased $50,000,000. In September, 1930, $125,000,000 more was made available. Due to exceptional weather conditions, these funds in many states were exhausted before the beginning of 1931. An emergency law was enacted by the federal government authorizing federal funds for highway construction amounting to $80,000,000, this to be used by the states to match the regular federal-aid allotment.

Federal aid was an important factor in the extension of highway programs in 1931. Many states had exhausted their highway funds and had it not been for this emergency appropriation they would not have been able to match the regular allotment and highway activity would have fallen far below that of 1930.

Gas tax funds

The gasoline tax amounted to $231,000,000 for the first half of 1930 and $245,000,000 for the first half of 1931, an increase of $14,000,000. Highway income from this source should not show a decrease from the 1930 figures, notwithstanding an almost certain decrease in automobile registrations. Increases in rates by 1931 legislatures in nine states and increasing vehicle operation should compensate for the decrease in motor vehicle production. Taxed gasoline consumption increased 200,000,000 gal. in the first half of 1931 over the corresponding period of 1930. The average tax rate increased from 3.39c. to 3.44c.

Local highway activity

Reliable figures are unavailable at this time concerning county highway activity for 1931. The year before was a peak year from the standpoint of expenditures; counties and townships spent $700,000,000 on local highways.

In making a review of 1931 activity consideration is given to increasing opposition to highway property taxes, the returns from which are the principal source of income for local highways. It is also probable that due to emergency relief measures by many local governments there is an overspent condition and highway funds are exhausted in some localities.

The results of the increasing opposition to local taxation are exemplified by the 1931 North Carolina legislature in the most radical enactment of the year concerning the financing and administration of local highways. On July 1, 1931, the state highway commission assumed control of 45,000 miles of county and township highways, abolishing the local tax, which was heretofore the principal source of financing for this mileage.

Adverse factors above mentioned affecting the improvement of local highways are to some extent offset by ever-increasing state aid. Allocation of funds by states to counties amounted to about $160,000,000 in 1930, and this should show an appreciable increase in 1931, due to generally favorable legislation.

It is probable that 1931 local highway activity will maintain the pace set in 1930 and due to existing low prices of materials and construction, the volume of work done should compare favorably with that of 1930.

Conclusion

There are several factors responsible for the maintenance of a normal highway program during a period of depression. The necessity for relief of unemployment has stimulated the expenditure of public funds. Low cost of construction and materials is an incentive for large construction programs. Increase in car mileage with the corresponding increase in gas consumption has made possible a continued uptrend in the most important source of state highway income.

The development of satisfactory low-cost surfacing has advanced rapidly during the past year. Increasing activity on secondary highways has stimu-

lated research and study in the use of bituminous materials by most of the states, and the improvement in this type of construction may be considered one of the outstanding construction trends for 1931.

Highway activity for the year has resulted in many changes in policies of administration and finance and some trends are becoming more clearly defined.

There is a marked trend toward the absorption of the township highway unit by counties. This consolidation has taken definite form in several states.

Legislation authorizing additional mileage on state systems was enacted in thirteen states. Pennsylvania added 20,000 miles of township highways. There is a trend toward more definite policies concerning the financing and administering of local highways.

The highway dollar assumed its maximum value in 1931. It paid for more quality and more volume than ever before in the history of roadbuilding.

Concrete Paving Practice on a 1,100-Mile Program

Notes on the standards of the Louisiana highway department in constructing the year's greatest mileage of hard-surfaced roads

By H. B. Henderlite
State Highway Engineer of Louisiana, Baton Rouge, La.

LOUISIANA, with a large bond issue and a governor determined to create a paved road system as a monument to his administration, led all states in 1931 in mileage of paved road constructed. Because of this leadership and the fact that it has had the opportunity of drawing on the latest knowledge and experience for its practice the construction methods employed have special interest. In the following article those methods are described by the state highway engineer under whose direction they have been adopted and carried out. The description is limited to concrete paving. —EDITOR.

LOUISIANA holds the record of 1931 for mileage of concrete road construction. The pavement section employed is double parabolic, 8 in. thick at the edges and 6 or 7 in. thick at the center; 600 miles of this pavement was constructed in 1930 and almost 1,100 miles in 1931. The maximum length of concrete pavement constructed per day was 8 miles, per week 40 miles and per month 165 miles. No standard 6-in. core, drilled from the pavement, has broken at less than 5,500 lb., the average being 7,400 lb. The average cost of pavement, including grading, drainage structures, guard rail and other incidentals, has been about $26,000 per mile.

Plant type and arrangement

In line with what we believe to be the best practice, the gravimetric proportioning of aggregates is used exclusively. The requirements of weighing equipment are virtually those recommended by the A.A.S.H.O. and include a definite arrangement of control levers, a telltale device in connection with the weighing beam, volumetric adjustment in the hopper compartments and accuracy to within 1 per cent of all loads, as well as all the other requirements, such as protection from wind, considered essential to dependable scale operation. Each batching plant is furnished by the testing laboratory with 400 lb. of certified 50-lb. weights and each weighing device is tested to full capacity once each week. The device is balanced twice each working day, and twice a day the scales are tested for sensitiveness by adding a 50-lb. weight to its total load.

Bulk cement has not been used to an appreciable extent, primarily because we have not been able to see the benefits that might be derived from accuracy in proportioning. We believe, however, that with improved equipment for the purpose certain economic benefits are possible.

Where one size coarse aggregate is used, the plant arrangement is usually a 110-ton two-compartment bin located a sufficient distance from the railroad track to allow convenient operation of a crane between the cars and the proportioning bin. Where delivery of materials can be controlled there is very little stock-piling done by the contractor and materials are mostly used direct from cars. While this arrangement has prevailed almost throughout, a few contractors have preferred that the crane operate on the offside of railroad cars where the movement of materials is such that stock-piling in appreciable amounts is not necessary. This method, of course, reduces considerably the crane swing. The arrangement, however, does not seem to be the most popular.

Where multiple-size coarse aggregates are used the arrangement is similar except that an additional bin is usually located about 150 ft. from the two-compartment bin and at an equal distance from the railroad track. This extra bin in the case of two sizes of coarse aggregate is converted into a single-compartment bin and the least amount of aggregate to be used, whether it be sand or one of the sizes of coarse aggregate, is stock-piled adjacent to and used through this extra bin. This arrangement reduces the crane travel and makes possible the use of three sizes of aggregate with a single crane, even though it is necessary to stock-pile in relatively greater amounts.

It is required that the size of mixers shall not be less than 27-E and that they be equipped with satisfactory batch meters and water-measuring devices. Tandem mixers were used on one project; the results were entirely satisfactory as to the quantity of concrete poured. The average daily run of these tandem mixers on 18 ft. 8x6x8-in. pavement was 1,302 lin.ft. The average daily run on another project under the same conditions and type of pavement, except that a single mixer was used, was 1,314 lin.ft. On both these jobs the mixing time was one minute.

Hauling in all instances has been by motor truck. Industrial railway systems have not been employed. The equipment has consisted of quite a variation in capacity. The tendency, however, has been to use a light single-batch truck with dual pneumatic tires at the rear. This is believed to be the most satisfactory equipment, especially in the case of bad subgrade conditions usually encountered throughout the southern section of the state as well as in the Mississippi and Red River valleys.

Materials control and mixes

The aggregates available for concrete in large quantities are a very good grade of sand and gravel of relatively small size, the maximum size being about 1 in. There is one stone deposit consisting of a semi-metamorphosed limestone cap of a salt dome, and through the cooperation of the highway commission this deposit has been developed extensively. As a result we have been able to secure in large quantities an aggregate ranging in size from 1 in. to 2½ in. Only this size crushed stone is used in concrete, the smaller sizes coming from the crusher being used in surface treatments on secondary-type roads. This larger-size coarse aggregate is used in combination with the smaller gravel as a multiple-size coarse aggregate. By this method the gradation of coarse aggregate is controlled to a remarkable degree and very satisfactory results have been obtained.

The method of mix design used might be called a trial method on a large scale. Before construction was started the laboratory had an opportunity to make thousands of trial mixes using all possible combinations and gradations of aggregates which would be available for the program. From the information obtained from these mixes, proportioning charts were prepared. Both the fine

and the coarse aggregates are classified as to grading by separating the particular aggregate into three sizes. This classifies the aggregate as to its gradation by contours drawn on trilinear charts. Once the aggregate is classified as to its gradation, the correct proportions consistent with workability, water content and therefore density are obtained from a second specially prepared chart.

This method, we believe, takes into consideration, more than does any other, all factors such as the effect of gradation of aggregates on the workability and density of concrete produced. We feel that remarkably uniform results have been secured which seem always to be a result of a uniform density rather than a uniform cement content. From this information the specifications were prepared stating the proportions of total aggregates to the cement as well as the approximate ratio of each aggregate but at the same time leaving for the contractor the possible economy of using a well-graded aggregate. This is an incentive for the contractor to secure and for the material producer to produce the best-graded aggregate practicable.

Finishing and curing

Special attention has been paid and rigid requirements have been enforced to insure a smooth riding surface, one of the most essential features governing the life of the pavement. Machine finishing is required in all cases except where pavement is widened on curves or at other special sections. In addition to machine-finishing, certain hand-finishing methods and tools are required. The contractor is furnished with a blueprint giving detailed drawings of these tools which he must have on the job before operations are started. It is required that the concrete be spread by hand to a uniform surface, which is from 1 to 2 in. above the grade of the finished pavement. The finishing machine is then required to strike off the concrete at least twice, and more if necessary, to produce a true cross-section, fill the voids and remove free water from the surface of the concrete.

After the concrete has been struck off by the finishing machine, it is required that a longitudinal float 12 ft. long and 20 in. wide shall be drawn across the concrete from form to form in the arc of a circle, the rear end of the float passing over and projecting beyond the form about 3 ft. at each stroke, the forward end of the float acting as a moving pivot and traveling in an arc of a circle, and remaining on the surface and about 3 ft. in from the form. The float advances longitudinally with each circular stroke so that there is an overlapping of the plain surface throughout the entire width of the road. No two trips across the surface are made in the same track. This operation is repeated as often as is found necessary to remove all depressions and high spots. Time is allowed for free water to rise and concrete to settle and shrink betwen operations; on the last operation, only sufficient water remains on the surface to permit easy pulling of the float.

After the concrete has been floated with the longitudinal float, it is floated with a transverse float 20 in. wide and 2 ft. longer than the width of the pavement. This float is worked from plow handles on each end and is moved up to the pavement in long sweeping strokes. This float is worked up and down the surface of the pavement as long as there is enough free water to permit its proper use. After the operation of the transverse float has been completed, the concrete is straight-edged with a 10 ft. straight-edge placed parallel to the center line of the roadway and any high spots or depressions found by this straight-edging are immediately corrected. The concrete is then given its final finishing by belting with a four-ply bow belt not less than 12 in. in width and 2 ft. longer than the width of the pavement. The pavement is belted until all free water has been removed and the final belting is given when the concrete has sufficiently set to produce a herringbone finish. The outer edge of the concrete pavement is then edged with a ¼-in. edging tool and brushed with a finishing brush.

Our specifications require that the surface shall not vary more than ⅛ in. under a 10-ft. straight-edge. Our inspectors have it impressed upon them that the time to correct irregularities in the surface of the pavement is while the concrete is still green and not by rubbing and marring the pavement after it has set up.

Curing has become a serious problem from a practical standpoint: Granting the merits of wet earth or ponding for curing does not by any means relieve the situation, since, owing to modern equipment, the progress made by most contractors means that with a ten-day wet-earth requirement more than a mile of slab has to be kept constantly wet otherwise we do not obtain the anticipated results. Fortunately, however, with the present-day high early strength of standard portland cement we obtain a higher degree of hydration during the first 24 hours, when the slab is covered with wet burlap, than was obtained with the slower hardening cements of the past. We do not believe that curing after this 24-hour period of wet burlap is of as much importance as it once was sometimes thought to be.

In addition to wet earth and ponding, calcium chloride used integrally during December, January, February and March is permitted. Its accelerating effect during the summer months sometimes makes its use impracticable because the methods of finishing require a period of time in which the concrete is likely to become too stiff for proper finishing. Silicate of soda is also permitted as an alternate method of curing and is applied after the pavement has been kept covered with burlap and thoroughly wet for 24 hours. This method of curing permitted in the early spring has proved very satisfactory and about 75 per cent of the pavement constructed during the summer months has been cured by this method.

Joint construction

No expansion joints have been used in the construction of 1,700 miles of paving. Some of this paving has been laid more than two years and about one-half of this mileage has passed through a temperature range of 70 deg. F. In this 1,700 miles we have had about 30 minor compression ruptures, and fully 50 per cent of these have been due to the forming of a diagonal plane of weakness in the slab caused by improper methods of construction when concrete operations were stopped due to breakdowns or other causes. Dummy joints are used and are spaced from 40 to 60 ft. depending on the type of subgrade. These joints are formed by depressing a steel strip cut to the crown of the roadway ¼ in. wide and 2½ in. deep into the concrete at right angles to the roadway and slightly below the surface of the pavement immediately behind the finishing machine. The finishing operations are carried on over these joints as usual. After the concrete has sufficiently hardened, these steel strips are pulled to about an inch above the surface of the pavement and the joints edged. Later they are entirely removed and the joints brushed lightly with a finishing brush.

Wayne County Pavements

WAYNE COUNTY, Mich., in which is the city of Detroit, has one of the greatest systems of concrete highways in the United States. The county has a pavement system of superhighways with 204-ft. rights-of-way at 3-mile intervals. At 1-mile intervals there are intermediate roads on 120-ft. rights-of-way and half-section roads on 86-ft. rights-of-way. Then there are more than 40 separated highway and railroad grade intersections, and three of the country's outstanding elevated highway intersections. Since 1909, when the first mile of concrete rural pavement was laid, Wayne County has placed more than 12,000,000 sq.yd. of concrete pavement. This represents approximately 280 miles of 20-ft. pavement and a similar mileage of 40-ft. or wider pavement. These roads are the result of a master plan which Wayne County adopted a number of years ago and to which its road commission has rigidly adhered. A contributing factor has been the permanence of the commission's engineering organization, many members of which have served for a decade and some since its inception.

Shortcuts That Simplify Surveying for Highways

Proved methods and computations that make the surveyor's work faster and easier in field and office

Unsymmetrical Crown Design

By Homer A. Humphrey

Instructor in Civil Engineering Department, Michigan College of Mining & Technology, Houghton, Mich.

THE field engineer confronted with the problem of placing a pavement between gutters that are of unequal elevation is well aware of the unsightly job produced if he uses a symmetrical parabolic section for the crown. Such a section is not only unsightly but dangerous, for most of the cross-slope is thrown into the low half of the pavement, and in icy weather it is difficult for the motorist to keep his car out of the low gutter.

The remedy for this is to design an unsymmetrical crown section such that the crown line or high point in the section is shifted toward the high gutter and the difference in elevation between these two points is lowered so as to produce an even cross-slope from high point to either gutter. The accompanying sketch shows the method devised by the writer to accomplish this end. This solution is based on the desire to obtain an equal straight line slope from the high point to both gutters. In accomplishing this, we fix both the elevation and the position of the high point in most sections.

The procedure is simply this: The total crown called for is divided by one-half the width of the pavement. The resulting answer is the slope per foot for the symmetrical section. If the crown is given in terms of slope, this operation is unnecessary (Eq. 1). The difference in elevation of the gutters is next divided by this slope to obtain the distance from the low curb to the point where the straight line slope is at the same elevation as the high gutter (Eq. 2). This distance, when subtracted from the total width of pavement, gives the portion of the pavement that will be symmetrical about the high point. Or, from the total width of pavement, may be subtracted the distance obtained by Eq. (2) and the remainder may be divided by two; the quotient is the position of the high point with respect to the high gutter (Eq. 3).

To determine the height of the high point above the high gutter, it is necessary to multiply the distance obtained by Eq. (3) by the slope obtained by Eq. (1), (Eq. 4). The result obtained by Eq. (4) when added to the difference in elevation of the gutters gives the difference in elevation of the high point and low gutter (Eq. 5).

The position of the high point with respect to both gutters is now known, as well as its height above each. This high point is the crown line of the section and is taken as the point of tangency from which separate parabolas are laid to each gutter. It is a property of the parabola that offsets from the tangent to the curve are to each other as the square of their distance from the point of tangency. This fact is utilized when solving for the elevation of any other point or points along the section.

This solution is easy and rapid, and is especially adaptable to slide-rule calculation. It will give results that absolutely check those obtained from the method advanced by Agg and that will compare favorably with results by the Bateman method. It has been used on pavements varying in width from 30 to 54 ft. and gave excellent results. With no changes, this method is applicable in all cases where the difference in elevation between gutters does not exceed 1½ times the total crown that would be used on a symmetrical section of the same width. The reason for this limitation is that a difference in elevation equal to 1½ times the total crown will put the high point at one-eighth the width of pavement, and experience has shown that the distance between high point and high gutter should never be less than this figure. If the difference in elevation should exceed 1½ times the total crown, the high point is placed at the one-eighth position until the long slope reaches ½ in. per foot or the short slope flattens to ⅛ in. per foot. When either of these conditions is reached, the cross-slope will be excessive and dangerous or the pavement will not be properly drained, and some adjustment must be made in gutter elevations.

Equations used in design of unsymmetrical crown

$$S = \frac{C}{\frac{W}{2}} \quad \text{Eq (1)}$$

$$W_1 = \frac{D}{S} \quad \text{Eq (2)}$$

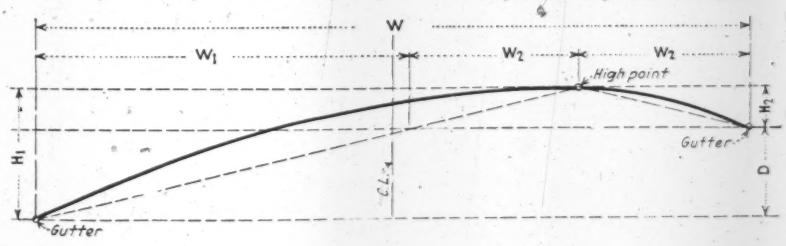
$$W_2 = \frac{W - W_1}{2} \quad \text{Eq (3)}$$

$$H_2 = W_1 \times S \quad \text{Eq (4)}$$

$$H_1 = D + H_2 = (W_1 + W_2) \times S \quad \text{Eq (5)}$$

$$\left(\frac{W_2 \text{ never less than } W}{8}\right)$$

Diagram showing method of designing unsymmetrical pavement crown.



Laying Out a Curve Without a Transit

By P. M. Tebbs

Assistant Chief Engineer, Pennsylvania Department of Highways, Harrisburg, Pa.

FREQUENTLY an approximately accurate method of laying out a curve suffices, particularly for surveys involving rural highway construction or when only preliminary information is desired. Such a method, which enables rapid performance and requires a minimum number of corpsmen, is as follows:

A temporary stake is placed where the two tangents intersect (point *X*) which is determined, as normally, by a visual inspection of existing ground conditions and local developments. Along both tangents measure from *X* distances of 50 ft. and place temporary stakes, thus establishing points *Y* and *Z*. Measure the distance between points *Y* and *Z*, and place a temporary stake at its mid-point so as to locate the direction of the external for whatever curve may be selected to satisfy the conditions imposed.

In the table in the left-hand column headed *YZ* pick out the distance nearest corresponding to the measured distance. If an appreciable difference exists between the two distances and greater accuracy is desired, a slight shift of either or both points *X* or *Z*, with an accompanying shift of *Y* if *X* is changed, will attain the results sought. Usually the function of a curve, aside from considerations of safety, that dictates just what curve should be adopted is the extent the curve location encroaches on adjacent property or the extent to which it necessitates earthwork. This distance is invariably the external of the curve, shown as *Xe* and designated *E*, although sometimes the tangent length *aX* or *Xf* is the con-

Highway Surveying Shortcuts

trolling function. Assuming, however, that external distance is the control, opposite the distance YZ used and under heading E find the distance which, after dividing by a number (degree of curvature), will result in a quotient representing the external needed.

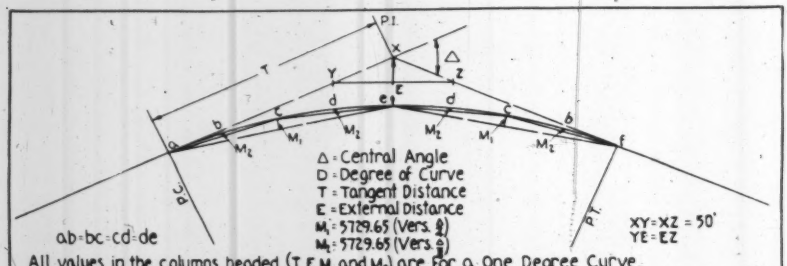
Measure the external, as above obtained, from X to c and drive a stake at the latter point, which becomes one point on the required curve. From the table and opposite the distance measured YZ divide the tangent distance T shown by the same number (degree of curvature) as used above in selecting E, and thus obtain tangent distance. From the point of intersection X measure this tangent distance along the tangents and drive stakes at a and f, which become points of tangency of the curves. Three points on the proposed curve have now been determined and located. If additional points are desired they can be obtained as follows:

Place temporary stakes at the midpoints of the measured chord lengths ac and fc and at right angles to the chord lengths measure distances of $M1$ (as determined by taking tabular value of M_1 from the table opposite the measured length YZ and dividing it by the degree of curvature), and thereby obtain two more points c on the curve. To obtain two additional points on the proposed curve, much as b, proceed similarly as outlined in preceding paragraph, using the distance found under column M_2, and dividing it by the degree of curvature used.

Intermediate points can be obtained by sighting them in by eye and if the resultant curve is satisfactory, offset stakes can be placed so as to avoid disturbances by construction operations.

To illustrate the applicability of the foregoing let us assume that the back and fore tangents have been established, the distance YZ measured as 90.5 ft., and that a building (or some other local control) exists on the inside of the curve so that to avoid encroachment of the highway on the control the center line of the contemplated curve must lie in such a position as to restrict the external distance E to a maximum of 60 ft. In the table is found a value of YZ as 90.6 ft., which is the closest value to the measured distance of 90.5 ft. Assuming that no further refinement is necessary requiring an adjustment of the points X, Z or Y, the value of 90.6 ft. as found in the table will be used. The flattest degree of curvature that can be used and which will satisfy the above requirement for E not to exceed 60 ft. is, therefore, 592.3÷60, or 10 deg. (to the nearest ¼ deg.). Accordingly place stakes so that E=59¼ ft., tangents T=267.2 ft., M_1=13.6 ft., and M_2=3.4 ft., thereby establishing nine points on the center line of the curve.

Chart for laying out curve without a transit.


P.I.
Δ = Central Angle
D = Degree of Curve
T = Tangent Distance
E = External Distance
M1 = 5729.65 (Vers. D)
M2 = 5729.65 (Vers. D/2)
ab = bc = cd = de
XY = XZ = 50'
YE = EZ

All values in the columns headed (T, E, M_1 and M_2) are for a One Degree Curve. Divide all values in those columns by the Degree of Curve used.

YZ	Δ (in Deg.)	T	E	M_1	M_2	YZ	Δ (in Deg.)	T	E	M_1	M_2	YZ	Δ (in Deg.)	T	E	M_1	M_2
100.0	1°	300.0	0.2	0.1	0.0	94.8	37	1917.1	312.2	74.5	18.7	80.4	73	4234.7	1398.0	288.2	72.5
100.0	2	150.0	0.9	0.2	0.1	94.6	38	1972.9	330.1	78.6	19.7	79.9	74	4317.6	1444.6	296.1	74.5
100.0	3	100.0	2.0	0.5	0.1	94.3	39	2029.0	348.6	82.7	20.7	79.5	75	4396.5	1492.4	304.1	76.5
99.9	4	200.1	3.5	0.9	0.2	94.0	40	2085.4	367.7	87.0	21.8	78.8	76	4476.5	1541.4	312.2	78.6
99.9	5	250.2	5.5	1.4	0.3	93.7	41	2142.2	387.4	91.4	22.9	78.5	77	4557.6	1591.6	320.3	80.6
99.9	6	300.3	7.9	1.9	0.5	93.4	42	2199.4	407.6	96.0	24.1	77.7	78	4679.8	1643.0	328.7	82.7
99.8	7	350.4	10.7	2.7	0.7	93.0	43	2257.0	428.5	100.6	25.2	77.2	79	4723.2	1695.8	337.0	84.9
99.8	8	400.7	14.0	3.5	0.9	92.7	44	2314.9	450.0	105.3	26.4	76.6	80	4807.7	1749.9	345.6	87.0
99.7	9	450.9	17.7	4.4	1.1	92.4	45	2373.3	472.1	110.1	27.6	76.0	81	4893.6	1805.3	354.1	89.2
99.6	10	501.3	21.9	5.4	1.4	92.1	46	2432.1	494.8	115.1	28.8	75.5	82	4980.7	1862.2	362.9	91.4
99.5	11	551.7	26.5	6.6	1.6	91.7	47	2491.3	518.2	120.0	30.1	74.9	83	5069.2	1920.5	371.6	93.7
99.5	12	602.2	31.6	7.8	1.9	91.4	48	2551.0	542.2	125.2	31.4	74.3	84	5159.0	1980.4	380.6	96.0
99.4	13	652.8	37.1	9.2	2.3	91.0	49	2611.2	566.9	130.5	32.7	73.7	85	5250.3	2041.7	389.6	98.2
99.3	14	703.5	43.0	10.7	2.7	90.6	50	2671.8	592.3	135.8	34.0	73.1	86	5343.0	2104.7	398.7	100.6
99.1	15	754.3	49.4	12.3	3.1	90.3	51	2732.9	618.4	141.3	35.4	72.5	87	5437.2	2169.2	407.9	102.9
99.0	16	805.2	56.3	14.0	3.5	89.9	52	2794.5	645.2	146.9	36.8	71.9	88	5533.1	2235.5	417.2	105.3
98.9	17	856.3	63.6	15.8	3.9	89.5	53	2856.7	672.7	152.5	38.2	71.3	89	5630.5	2303.5	426.6	107.7
98.8	18	907.5	71.4	17.6	4.4	89.1	54	2919.4	700.9	158.3	39.7	70.7	90	5729.7	2373.3	436.1	110.1
98.6	19	958.8	79.7	19.7	4.9	88.7	55	2982.7	729.9	164.2	41.2	70.1	91	5830.5	2444.9	445.8	112.5
98.5	20	1010.3	88.4	21.8	5.4	88.3	56	3046.5	759.6	170.2	42.7	69.5	92	5933.2	2518.5	455.5	115.1
98.3	21	1061.9	97.6	24.1	6.0	87.9	57	3110.9	790.1	176.3	44.2	68.8	93	6037.8	2594.0	465.3	117.5
98.2	22	1113.7	107.2	26.4	6.6	87.5	58	3176.0	821.4	182.5	45.8	68.2	94	6144.3	2671.6	475.2	120.0
98.0	23	1165.7	117.4	28.8	7.2	87.0	59	3241.7	853.5	188.8	47.4	67.6	95	6252.8	2751.3	485.2	122.6
97.8	24	1217.9	128.0	31.4	7.8	86.6	60	3308.0	886.4	195.2	49.0	66.9	96	6363.4	2833.2	495.3	125.2
97.6	25	1270.2	139.1	34.0	8.5	86.2	61	3375.0	920.1	201.7	50.7	66.3	97	6476.2	2917.3	505.6	127.8
97.4	26	1322.8	150.7	36.8	9.2	85.7	62	3442.7	954.8	208.4	52.3	65.6	98	6591.2	3003.8	515.9	130.5
97.2	27	1375.6	162.8	39.7	9.9	85.3	63	3511.1	990.2	215.1	54.0	64.9	99	6708.6	3092.7	526.3	133.1
97.0	28	1428.6	175.4	42.7	10.7	84.8	64	3580.3	1026.6	222.0	55.7	64.3	100	6828.3	3184.1	536.8	135.8
96.8	29	1481.8	188.5	45.8	11.5	84.3	65	3650.2	1063.9	228.9	57.5	63.6	101	6950.6	3278.1	547.4	138.5
96.6	30	1535.3	202.1	49.0	12.3	83.9	66	3720.9	1102.2	235.9	59.3	62.9	102	7075.5	3374.9	558.1	141.3
96.4	31	1589.0	216.2	52.3	13.1	83.4	67	3792.4	1141.4	243.1	61.1	62.3	103	7203.1	3474.4	569.0	144.0
96.1	32	1643.0	230.9	55.7	14.0	82.9	68	3864.7	1181.6	250.4	62.9	61.6	104	7333.6	3576.8	579.9	146.9
95.9	33	1697.2	246.1	59.3	14.8	82.4	69	3937.9	1222.7	257.7	64.8	60.9	105	7467.0	3682.3	590.9	149.7
95.6	34	1751.7	261.8	62.9	15.8	81.9	70	4011.9	1265.0	265.2	66.7	60.2	106	7603.5	3791.0	602.0	152.5
95.4	35	1806.6	278.1	66.7	16.7	81.4	71	4086.9	1308.2	272.9	68.6	59.5	107	7743.2	3902.9	613.2	155.4
95.1	36	1861.7	294.9	70.5	17.6	80.9	72	4162.8	1352.6	280.4	70.5	58.8	108	7886.2	4018.2	624.5	158.3

Preparing Birdseye Views From Engineering Plans

By William Van Breeman

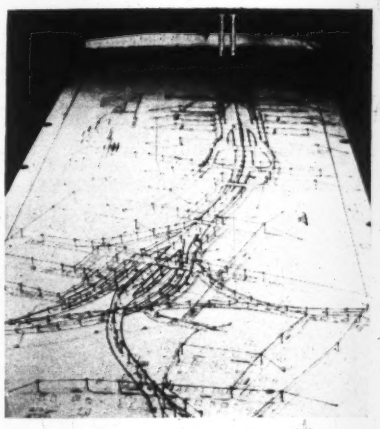
New Jersey State Highway Commission, Trenton, N. J.

THE New Jersey state highway department has frequently been called upon to prepare perspective drawings of certain portions of highways that have been designed but not yet constructed; particularly when elaborate or unusual facilities are contemplated. Since the aim has been to prepare pictures that will accurately represent the contemplated work, the following method of determining the true positions and sizes of the essential elements of the pictures was devised.

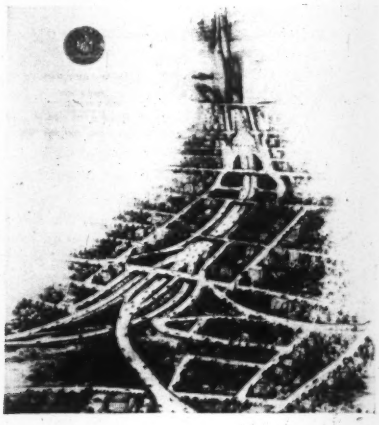
A plan, preferably a black-line print, of the contemplated work is attached to a drawing board, as shown at the left in the accompanying illustration. The plane of the drawing board is assumed to be at some elevation lower than the lowest point within the area considered. Pins are driven at each engineer station in the center of all roads to such depth that the tops of the pins will correspond to the finished grade. A line passing through the tops of the pins is a true representation of the center lines of the roads both as to horizontal and vertical position. In the view herewith the black threads stretched from one pin to another represent the true positions of the center lines of the roads making up the New Jersey approach to the Hudson River bridge. The two spikes in the upper part of the picture represent the bridge towers. Following this, the plan is photographed from one or more points, and the photograph showing the work from the most desirable point of view is selected as a base. The selected photograph is enlarged to the desired size of the finished drawing. Tracing cloth is laid over the enlarged photograph and the roads, using their widths as photographed, are centered about the center lines determined by the tops of the pinheads. The result is an outline of the roads in true width and position. This so-called base drawing is turned over to a person with artistic ability who uses it as a guide under his drawing and who fills in the trees, buildings, slopes, bridges, etc., as are necessary to complete the picture shown at the right.

The left-hand view represents our first attempt at using this method. It is probably more expedient to place the pins along the side lines of the roads, for then a line drawn through their tops

Highway Surveying Shortcuts



From the engineering plan above, on which pins indicate the vertical heights of several parts, the birdseye view, below, of the structures in the Hudson River bridge approach was prepared



locates the position of one of the side lines immediately. Vertical pins of known height may be driven at random points in the plan to assist in determining the correct height of any structures located in their vicinity. The correct direction of all shadow lines may be determined by drawing a series of parallel lines on the plan corresponding to the assumed direction of sunlight. Points difficult to determine in perspective, such as the intersection of planes or slopes and existing structures, may readily be determined with accuracy by this method.

Elliptic Cross-Sections for Pavement

By John R. Jahn
Civil Engineer, San Francisco, Calif.

ELLIPTIC arcs for the cross-sections of streets provide wider crown portions and make smoother connections with the pitch of the gutter than do the parabolic arcs ordinarily used. Having a major and a minor diameter and a closed figure, an elliptic arc can be selected to meet any gutter pitch. If this is made relatively steep, the road crown can be made nearly flat from gutter to gutter without losing its water-shedding ability. Computation of the ordinates of an ellipse to meet any set of conditions can be made by slide rule or computing machine, using the following simplified formulas, which take into account the width and crown rise of the street section together with the pitch of the gutter away from the street section. In the equations:

L is the distance from the centerline of the street to the lip of the gutter.

H is the difference in level between the road crown and the lip of the gutter.

m is the transverse slope of the gutter or the slope of a tangent to its lip if curled upward.

C is the distance above the crown point at which the tangent line from the gutter intersects the center vertical. $C = Lm = H$.

A and B the major and minor elliptic semi-diameters.

x and y the abscissa and ordinate, respectively, of any point on the transverse curve.

The general equation of an ellipse referred to an origin at the end of the minor axis is:

$$\frac{-2By - y^2}{B^2} = \frac{x^2}{A^2} \qquad (1)$$

or $$y = \frac{B}{A}\left(A - \sqrt{A^2 - x^2}\right) \qquad (2)$$

The slope of the tangent at $x = L$ and $y = H$ is:

$$m = dy/dx = \frac{B^2}{A^2}\,\frac{L}{(B - H)} \qquad (3)$$

$\frac{B^2}{A^2}$ can be taken from (1)

and $$m = \frac{C + H}{L}$$

Hence, $$B = \frac{CH}{C - H} \qquad (4)$$

or $$\frac{1}{B} = \frac{1}{H} - \frac{1}{C} \qquad (5)$$

From (1) $$A = \frac{Bx}{2By - y^2}$$

and by substitutions of B, x and y,

$$A = \frac{CL}{C^2 - H^2} \qquad (6)$$

Equation (2) may now be used to obtain the ordinates, y, for any point x. It does not cover the case in which the gutter slope is flatter than the tangent to the parabolic arc. Such a curve is a hyperbola. The following general equation takes it into account:

$$y = \frac{H}{L(C - H)} \times \left(CL - \sqrt{C^2L^2 + x^2H^2 - x^2C^2}\right) \qquad (7)$$

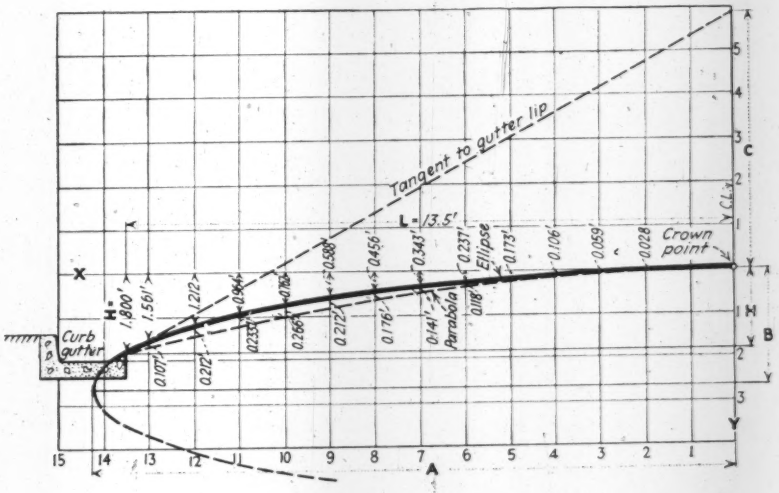
When $C = H$, y is infinitely great and the curve is a parabola. In that case:

$$y = H\frac{x^2}{L^2} \qquad (8)$$

Comparative elements of a road section are shown in the accompanying figure. The ordinates for the elliptic arc are given for each foot and were computed using equations (2), (5) and (6). The parabolic arc below the ellipse is obtained from equation (8). At 10 ft. from the centerline the ellipse is more than 3 in. above the parabola for a gutter pitch of ½ to 1. This is an exaggerated case, being chosen to emphasize the relations between ellipse and parabola, and the gutter transition curves.

When streets have gutters at different levels on opposite sides of the roadway, each side may be treated separately for the particular crown rise and gutter pitch desired. The two arcs will then meet on tangent on the centerline of the street.

Comparison of street cross-sections computed from elliptic and parabolic curves.



NEWS OF THE WEEK

Pasadena Votes Recall of Board of City Directors

In the first successful recall election in the history of Pasadena, Calif., voters on Dec. 28 recalled the entire board of city directors and replaced the seven members with candidates sponsored by the Pasadena Association, an organization which launched and conducted a vigorous campaign for the recall. Members of the recalled group had been charged by leaders of the Pasadena Association with internal dissension and inability to cooperate for the city's welfare. The resignation of R. V. Orbison as city manager and the appointment of J. W. Charleville to that post, after prolonged consideration of a number of candidates, was one of the principal points at issue with the board which has now been recalled.

Work to Continue on Beauharnois Plant Throughout Winter

In order to help stabilize employment in the Montreal region, work on the canal and power plant of the Beauharnois Power Corp. on the St. Lawrence River above Montreal is to be carried through the winter months without any layoff of men. Work during the winter months will include the erection of three bridges across the canal, placing rock on the inner side of the canal banks to prevent erosion, excavation in the boulder-clay section of the canal, reconditioning the construction equipment, finishing the interior of the plant and installation of hydraulic and electrical equipment to produce an initial output of 200,000 hp. next summer. In this way the company expects to be able to keep an average of 2,000 men on its payroll during the winter. Last winter the force was reduced to about 600.

Serious Tax Crisis in Chicago

Decision of a Cook County judge to the effect that the 1928 and 1929 tax levies were illegal has thrown the financial affairs of Chicago and other local governments into an extremely serious situation. By this decision the 1930 levy is just as illegal. The belated bills for the 1930 taxes were to be sent out soon but will now probably be still further delayed. Sale of 1930 tax anticipation warrants is rendered almost impossible by the decision.

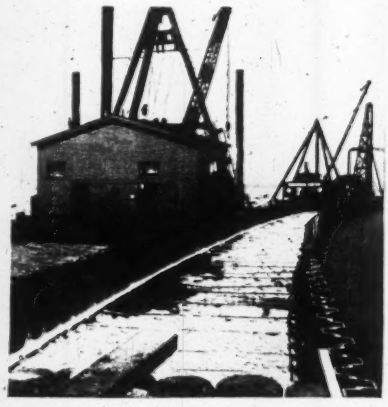
The state legislature has been in session several weeks. It has done little, though called for the special purpose of bringing some order out of the county's tax muddle. Downstate legislators have awaited some concerted action by Cook County representatives, who during the holidays seemed finally, under strenuous pressure of the mayor of Chicago and other heads of the local governments, to have come to a compromise as to future action. This called for the simplification of the assessing machinery which would be acceptable to the political parties and the banks. The latter have steadfastly refused to buy tax anticipation warrants until the tax-assessing machinery was revamped.

Following the decision of invalidity came a proposal to fund the 1930 taxes and those unpaid of 1928 and 1929 by bond issue validated by the state legislature. This would amount to some $388,000,000. To this procedure the bankers are lukewarm. A frantic attempt to get the decision reversed by the state supreme court is being made. The decision is based principally on the unworkable constitution of the state, which requires personal property and real estate to be assessed at the same rate.

In the meantime the Sanitary District of Chicago, Cook County Forest Preserves and the West Park Board have defaulted on interest and bond principal due Jan. 1. Also several local schools have had to close down for lack of cash to pay teachers and janitors. A serious situation also confronts every small municipality because of the inability to realize on tax credits.

Three Large Cement Mills Have Perfect Safety Record

Three of the largest cement mills of the Universal Atlas Cement Co. went through 1931 without a lost-time accident. During the month of June all nine of the company's plants operated without an accident. The three mills having a perfect year's record are those located at Northampton, Pa., Leeds, Ala., and Independence, Kan.



STEEL-PILE BULKHEAD, LINCOLN PARK, CHICAGO

The shore-line bulkhead for extension of Lincoln Park consists of two rows of steel sheeting with steel wales and tie-rods and rock filling. The inclosed water space, at the left, is being filled with sand pumped from hopper dredges. The Great Lakes Dredge & Dock Co. is doing the work for the Lincoln Park Commission.

Baltimore Appoints Smoke Control Commissioner

Norman A. Hill has been appointed commissioner for smoke control of Baltimore, Md., and will be the head of a new bureau under the supervision of Bernard L. Crozier, chief engineer of the city. The ordinance provides that the head of the bureau be an engineer. Mr. Hill will organize the department and will act in cooperation with an advisory board to be appointed by Mayor Jackson.

Boston Lets 10-Year Garbage Disposal Contract

A ten-year contract for the final disposal of garbage, ashes and refuse, street sweepings and catchbasin cleanings of Boston was let on Dec. 28 to the Brooklyn Ash Removal Company of Massachusetts for a total of $3,780,000. The price named was the lowest of five bids received Nov. 18, 1931, on a sliding-scale yearly basis. (See *Engineering News-Record*, Dec. 24, 1931, p. 1,020, for summary of bids, population and estimated quantities.) Specified methods of disposal are: garbage, by reduction; clean ashes and other heavy material, dumping at sea; all other material, filling marsh lands.

The reduction process must be conducted on Spectacle Island, on land and wharves and in buildings owned by the city and now used by the present garbage-disposal contractor; but the new contractor must provide equipment for reduction—presumably he will take over the old equipment. It was erroneously stated, in the earlier notice already mentioned, that Metcalf & Eddy, of Boston, were consulting engineers for this work.

Indiana Paving Contracts to Go to Local Firms

The Indiana highway commission has adopted Gov. Leslie's views favoring the award of paving contracts to Indiana firms as a means of solving the unemployment situation in the state. According to the governor's views, local contractors should be favored where the difference in prices is slight, but where Indiana firms are more than second or third from the low bid, they must meet the out-of-state price to get the business.

$3,000,000 Bridge to Be Built Across Fraser River

With financing completed, engineers of the Ladner Bridge Co. will start work early in the spring of 1932 on the bridge to be built across the Fraser River at Ladner, B. C. The project will cost $3,000,000 and when completed will form an important link in the arterial highway now under construction between Vancouver and the international boundary line.

Gen. Brown Favors Ring Levees on the Mississippi

RING levees should be constructed around Monroe, Simmsport and Melville, in Louisiana, in the opinion of Major Gen. Lytle Brown, Chief of Engineers. Gen. Brown has announced that he is ready to proceed at once with the construction of such levees, provided approval of the local authorities can be obtained. These centers of population should be protected against the possibility of an unusual flood, Gen. Brown states. If protected by levees, they would provide places of refuge for the people in the surrounding areas in case of flood. In Gen. Brown's opinion no work is likely to be undertaken on the west bank of the river until extensive studies have been made of the possibilities of increasing the carrying capacity of the Mississippi between Arkansas City and Red River Landing and of the problems in the Atchafalaya basin. If Gen. Brown is called before the flood-control committee he will recommend legislation authorizing thoroughgoing studies of that character.

Could cut off many bends

Experiments in the hydraulic laboratory at Vicksburg have produced results which indicate that many bends in the main river can be cut off to advantage. There is also the problem of deepening the river in the Natchez sector. Gen. Brown is unwilling to undertake such work, however, until much more careful engineering studies have been made. He points out that ample time exists for such studies, as there is still three years' work to be done on the main river levees, which he thinks should be given priority, in any event.

While these engineering studies are in progress, the people of the Boeuf basin are anxious that the fuse-plug section of the levee be built up to the height of the levees above and below. Gen. Brown points out that this could not be done unless Congress authorizes it.

Gen. Brown is inclined to regard favorably the possibilities of straightening and deepening the main river, but he would not undertake this without careful studies, which, he thinks, may show that the diversion can be brought farther south than Cypress Creek.

Indiana Highway Commission Has $6,367,762 Balance

A balance of $6,367,762 remained in the treasury of the Indiana highway commission at the close of the fiscal year. The large balance was caused by an injunction of the circuit court which stopped the department's plan of building about 200 miles of bituminous surface road.

California Saved From Water Shortage During 1932

Fears of water shortage in California next summer have vanished with the rain and snow which has continued to pour down for the past few weeks. The seasonal rainfall to date nearly doubles the normal fall for this time of year.

Engineers Discuss Problems at New Orleans

MEETING in New Orleans Dec. 29-30, the American Association for the Advancement of Science, in its Section M (Engineering), had an interesting program arranged with the cooperation of a local committee of engineers of which W. B. Gregory, professor of experimental engineering and hydraulics, Tulane University, was chairman.

Lieut. H. D. Vogel, U. S. Engineers, in charge of the U. S. Waterways Experiment Station, Vicksburg, Miss., in a paper on "Laboratory Solution of River Problems" pointed out the difficulties encountered by experimenters in designing, building and operating small-scale models of rivers, the need for better approach to this problem for rivers of large size, and the absolute need for the use, in the case of long stretches of rivers, of distorted models—that is, with vertical scale considerably in excess of horizontal. He showed that it is possible to get good relationships between results with distorted models and the results of observations of actual river performance.

Rainfall at New Orleans

George G. Earl, of the Sewerage and Water Board of New Orleans, gave a complete analysis of rainfall at that city, showing that 3 in. or more in one hour occurred eight times since 1895 and there has been 14 in. in nine hours

ALL-STEEL AND ALL-CONCRETE OFFICE BUILDINGS IN HOLLAND

Two examples of modern office-building construction in Rotterdam, Holland, are here illustrated. The three-story building on the left has steel walls and window frames, the former being insulated by a layer of cork and hollow brick. Floors are of reinforced concrete and asphalt; the roof of linoleum and rubber. The fourteen-story structure on the right has a reinforced-concrete frame and steel windows. DeVries, Robbé & Co., Rotterdam, erected the steel, including windows, for both buildings. The Hollandsche Beton Maatschappj, 's Gravenhage, was the contractor for the fourteen-story concrete building.

over the entire area of the city. Removal requires an elaborate system of canals and pumping stations, the water being sent to Lake Pontchartrain, Lake Borgne or the Mississippi, according to conditions. Since all of city lies at near or even below Gulf level, it is necessary to remove all rainfall except that absorbed. Present capacity is equivalent to the removal of 1¼ in. of rain over the entire area in 24 hours, a considerably greater discharging capacity than that of Chicago with ten times the drainage area. There is need for numerous and complete records of rainfall and run-off. This prompt removal of storm-water, combined with improved sewage disposal and water filtration, has resulted in great improvement of sanitary, and, consequently, of living conditions.

Necessity of street railways

C. F. Hirshfeld, director of research, Detroit Edison Co., stated that for cities of 100,000 and upward the continuation of the street railway is a necessity to provide transportation for the common man. At present 60 per cent of downtown transportation is by street car, and only 8 per cent of the original street railway mileage has been replaced by buses. Thanks to early profits, the perpetuation of outmoded ideas resulted from ingrowing administration. Development of new ideas is now necessary to make the street car sufficiently attractive to compete with other forms of transportation. Through combined interests of companies exact facts are now being learned. Great demand is for better ventilation and quietness of operation rather than for mechanical perfection and speed. One feature of the case is that means must be found to save an investment of 5½ billion dollars, which if lost would have to be replaced at even greater cost.

New function for the engineer

The address of the retiring vice-president and chairman of the section, Frank B. Jewett, director, Bell Telephone Laboratories, dealt with the new place that must be taken by the engineer, for society cannot continue to live in a highly mechanized age on the rules and regulations suited to an earlier trading and agricultural age. Engineers must become more competent to take a proper place in the whole scheme of society. The education of the rank and file so that they will understand that we cannot fool ourselves on matters of science and engineering without Nature taking her revenge is part of the new duty of engineers.

Foundation problems in New Orleans

John F. Coleman, past-president, American Society of Civil Engineers, dealt with foundation problems in New Orleans. The existence of alluvial deposits 1,000 to 1,500 ft. deep, complicated by local deposits of quicksand at a few feet of depth and in other places with decayed vegetation and soft clay —all these things present a foundation problem of unusual difficulty. Until recently most of the material was saturated at a depth of only a few feet. In general the surface affords better bearing than the underlying material. In some cases the lowering of the line of saturation has resulted in decay of the grillage with consequent settling of buildings. In other places this lowering has resulted in settling of material even without load, in some cases as much as 2 ft. The proper arrangement of piles is of unusual importance.

Other papers

Major R. F. Fowler, U. S. Engineers, in charge of the First New Orleans District, discussed inland waterways, and J. H. Pound, professor of mechanical engineering, Rice Institute, Houston, Tex., showed the remarkable development of pipe-line transportation of natural gas, oil and gasoline during 1929-31, a development so important as seriously to threaten the prosperity of the railroads in these regions.

Hoover Dam Notes

In view of a report submitted by Dr. F. L. Ransome on the geology of the Hoover Dam site, a new location has been selected for the intake towers. Designs for the bulkheads at the inlets of the outer diversion tunnels and for the outlet works are in progress.

Oiling of the construction highway in Hemenway Wash has been completed. The oiling of the water trail canyon road to the lower portals of the tunnels is about complete. Excavation was started for a cofferdam at the inlet end of tunnel No. 3.

In the two weeks from Dec. 12 to Dec. 26 a total of 539 lin.ft. of 12x12-ft. pioneer headings was driven. The pioneer heading downstream from the central adit in tunnel No. 4 was holed through into the enlarged heading being driven from the outlet portal. A total of 14,473 ft. of pioneer tunnels had been driven to Dec. 26. A 41x56-ft. enlarged heading was started at the inlet of tunnel No. 1. Enlarged headings are now being driven from outlet and inlet portals of all four tunnels. During the past two weeks a total of 1,069 ft. of enlarged headings was driven, bringing the total driven to date to 1,838 ft.

At Boulder City the rough grading of all streets is complete. Laying of sidewalks is 60 per cent complete, and nearly all curb work is finished. The administration, municipal and dormitory buildings are nearing completion.

A survey shows there are 228 children of school age in Boulder City. Las Vegas is taking care of 58 of these who make the round trip each day.

$6,000,000 Building Program at Texas Universities

The University of Texas has called for bids to be received Jan. 29 on between $3,500,000 and $4,000,000 worth of buildings. These include physics, geology, home economics, architecture and engineering classroom buildings, an addition to the library, a men's dormitory and a student union activity building. Contracts for $183,000 worth of road work on the campus have just recently been let. Texas A. & M. College will launch a $2,000,000 program immediately. Money for both of these programs comes from oil royalties on land owned by the University of Texas.

Columbia Projects Not Favored by Army Engineers

BECAUSE the army engineers can find no justification for either of the major projects proposed for the Columbia River the Board of Engineers for Rivers and Harbors has asked all interested parties to submit to it before Feb. 10 their views as to what justification there is for undertaking either or both projects.

A survey and investigation of the navigation, power development, flood-control and irrigation possibilities of the Columbia River in Washington and Oregon was authorized by Congress in 1927. These surveys have been completed by the district and division engineers of the army and are now before the rivers and harbors board for action.

Two features of the plan

The two most important features of this plan are a project for power development below the mouth of the Snake River, combined with the improvement of navigation, for a depth of 9 ft. from the mouth of Snake River to the head of tide, and a combined project for the development of water power at a dam in the Columbia near the head of Grand Coulée and for the irrigation of a large tract of land known as the "Columbia Basin" by water pumped from the Columbia River by power developed at this site.

The following considerations unfavorable to the projects have been advanced: The project on the lower river is primarily a power project on a very large scale, an ultimate installation of over 4,000,000 kw. being contemplated. The estimated cost of the complete project is more than $450,000,000. At the present time there is no market for this large amount of power and very many years would be required before such a market could be developed. The navigation improvement is only a minor adjunct of the power development, and it appears unnecessary and undesirable to adopt a federal project for navigation contingent upon the development of the power by local interests until a stage is reached when there is a probability that such power development may be undertaken in the reasonably near future.

The Grand Coulée project

The Grand Coulée power and irrigation project also involves a very large power development. It has been estimated that 25 years might elapse after the completion of construction before the entire power could be disposed of. The cost of irrigation by this project is high and financing would be impossible on the basis of returns from the sale of irrigation water even if no interest charges were considered. The financing of the entire combined project by the combined receipts from the sale of water and the sale of power might be possible under certain conditions. Such financing would require the use of the profits of the power development to provide irrigation. Whether or not such profits would be sufficient would be dependent on the growth of the demand for elec-

tric power over a period in the comparatively distant future. The total investment required would be about $400,000,000. Agriculture in the United States has been suffering from overproduction for many years. It does not appear that large expenditures by the federal government for the purpose of bringing new land under cultivation are justified at the present time.

Information submitted to the rivers and harbors board will be considered by it in making its decision.

Abandonment of Whitestone Line Approved

The right of Interstate Commerce Commission to authorize abandonment of the Whitestone branch of the Long Island R.R., a subsidiary of the Pennsylvania, has been affirmed by the U. S. supreme court. The line is a commuting railroad serving residents on the north shore of Long Island now entirely within the city of New York. Because the line is entirely within the city as well as within the state of New York, both the state and the city contested the right of the commission to authorize abandonment, which was first proposed when the Long Island was ordered to eliminate several grade crossings on the branch. The railroad claimed that the line was being operated at a loss and that to add the cost of expensive grade-crossing elimination work would so seriously affect its other operations as to be detrimental to its interstate business. The commission upheld this contention, authorized abandonment and ordered the railroad to substitute a bus and truck service. Subsequently, when the city would not negotiate with the railroad concerning the substitute service, the commission canceled that part of its order. The supreme court confirms the commission's right to jurisdiction over this purely intrastate line on the ground that the amount required to be spent upon it might have an effect on interstate traffic.

Col. Deakyne Retires From Army Under Age Limit

Col. Herbert Deakyne, head of the board of engineers for rivers and harbors, Corps of Engineers, U. S. Army, retired from active service on Dec. 31, having reached the age of 64. Although a native of Delaware, Col. Deakyne spent the major part of his active service in the army on the Pacific Coast, and he expects to return to the Coast now that his tour of active duty is completed. Twice during his career Col. Deakyne has held the rank of brigadier general, first in 1918 and 1919 as chief engineer of the Second Army in France, and then from July, 1926, to July, 1930, as assistant Chief of Engineers, U. S. Army, at Washington. Col. Deakyne organized and took to France the 19th Engineers (Ry.), a shop regiment, and later commanded the 11th Engineers (Ry.) during part of its service with the British army. Subsequently he was director of light railways and roads of the American Expeditionary Force and chief engineer of the Paris group before the organization of the Second Army. He retires with the rank of brigadier general.

New Terminal Plan for Chicago

A union station at Randolph St. east of Michigan Ave. is proposed by the Chicago Plan Commission as a solution of the old and complicated problem of modernizing the four passenger stations south of the loop district, which together serve seventeen railroads. This site, occupied now by railroad freight yards, warehouses and coal yards, is adjacent to the new suburban terminal of the Illinois Central R.R. (*ENR*, Sept. 3, 1931, p. 360) and convenient to both the loop district and the shopping and office district now developing north of the river. The cost is estimated at $26,000,000, including land, station and air-rights buildings for offices and stores. But in addition there would be great expenses for the various roads in relocating their lines to get access to the new terminal. Furthermore, extensive plans are on paper for the reconstruction of each of the present four terminals. The attitude of the railroads toward this new project remains to be seen.

Highway Regiment Reunion

The 23d Engineers, the principal highway regiment of the U. S. army in France during the World War, has taken a booth at the Road Show, at Detroit, Jan. 11-15, to provide a place where former members of the regiment may congregate. The regiment was made up of 4,800 highway engineers from all parts of the country and at the peak of its activities directed the work of many other pioneer and labor regiments.

WASHINGTON NOTES

By PAUL WOOTON
Washington Correspondent

Dispute as to Damage Payments to Railroads Holds Up Work on Dams in the Upper Mississippi

IN ORDER to protect their interests, railroads whose tracks lie adjacent to Dam No. 4 in the upper Mississippi at Alma, Wis., are seeking an injunction to restrain the war department from going ahead with the work until the matter of damage payments is clarified. The dam is to be one of a series of a roller gate type of structure that is called for in the program of improving the upper Mississippi for navigation. Eventually, 24 movable dams will be built between the mouth of the Illinois River and St. Paul so as to insure a 9-ft. depth. The federal court of jurisdiction already has indicated that it will issue an injunction. As a result, the war department has withdrawn its advertisements for bids for the work.

The railroad principally concerned is the Chicago, Burlington & Quincy. The cause for action in the railroad's case is strengthened by the fact that the final survey of the upper Mississippi recently submitted to Congress by the army engineers provides for a dam of higher pool elevation at Alma than was specified in the tentative report. Congress officially adopted the tentative report in the section of the last rivers and harbors bill authorizing the 9-ft. project on the upper Mississippi. In the tentative report a pool height of 670 ft. for the dam was recommended. The final report proposes an ultimate pool elevation of 670 ft. at the Alma dam site. It is understood that the railroads contend that the army engineers have no authority to alter the specifications approved by Congress.

On the other hand, the army engineers point out that it was not proposed that the tentative report should fix the final locations for the dams or should make the preliminary specifications absolute. The development of events at the Hastings lock and dam serve to increase apprehension on the part of the railroads as to the payment of damages. In this instance, government representatives raised the point that the railroad tracks are not located above the maximum high water mark. It was contended in behalf of the government that recognition should be given this fact in fixing the amount of money to be paid to the railroads.

Stimulating Home Remodeling

The first of the "follow through" organizations growing out of the President's Conference on Home Building and Home Ownership has been set up in the committee on reconditioning, remodeling and modernizing, under F. M. Feiker, chairman. It is undertaking a broad campaign through local committees looking to the stimulation of remodeling work.

To Investigate Freight Rates on Iron and Steel Pipe

With a view to establishing a proper relationship of rates between all producing points, iron and steel pipe manufacturers in Eastern territory have asked the Interstate Commerce Commission to undertake a general investigation of rates from, to and in Western trunk line territory. The petition alleges that rates on pipe resulting from the commission's order of Dec. 2 are unreasonable and prejudicial. The belief is expressed that the commission does not clearly understand the situation with respect to pipe rates from Pittsburgh, Youngstown and Lorain versus rates from Chicago and Milwaukee to Western territory.

No Ferry for Panama Canal

Holding that it would be improper to permit private enterprise to enter the Canal Zone, the secretary of war has turned down an application for a ferry service across the canal. It was also proposed in this application that service be permitted on Gatun Lake. Secretary Hurley not only is opposed to any use of the government facilities in the Canal Zone for private profit but believes that the service proposed in the application would interfere with the government transportation system.

To facilitate work on the Madden Dam, a highway has been constructed from Panama City to the construction site. Only 20 miles of additional road-building would be necessary to extend this highway to Colon. Mr. Hurley believes, therefore, that the completion of this highway work will make points in the Canal Zone more accessible and will remove any necessity that may exist for additional transportation facilities.

Brief News

NINE APPLICATIONS have been received for the position of city engineer of Sydney, N. S., to succeed R. M. McKinnon, who resigned recently.

FOR RELIEF OF UNEMPLOYMENT the Canadian government has made final arrangements with the provinces, providing for an expenditure of about $70,000,000. This includes the combined contributions of the federal, provincial and municipal governments for construction work, but does not include amounts to be spent for direct relief.

PUBLICATION of the *Bulletin* of American Engineering Council has been suspended because of a falling off of income among the member organizations.

ISSUANCE of 2½ million dollars in bonds to build a municipal electric light and power plant has been authorized by the city council of Augusta, Ga.

A $75,000 BOND ISSUE for improvement of the water plant of Canton, N. C., has been approved and the bonds will be offered for sale soon. The water will be taken from Pigeon River. A new filtration plant will be built and the city mains will be expanded.

EXPENDITURE of $1,322,000 for water main extensions and replacements is Buffalo's program for unemployment relief. Of this total nearly $800,000 is for labor.

TO FINANCE the city's public works program, the city council of Charlotte, N. C., has approved a bond issue of $300,000 divided into four classifications: water bonds, $30,000; sanitary sewer bonds, $60,000; street improvement bonds, $190,000; and extending public streets, $20,000.

UNUSUAL PROBLEMS were presented in the design of the gas cell storage building to be constructed by the U. S. navy department at Lakehurst at an estimated cost of $200,000. The building will store the gas containers used by the large naval airships. Because of the tendency of the fabric of the gas cells to deteriorate under adverse moisture conditions or heat, it has been necessary to make provision in the plans for an air-conditioning system and for insulated walls.

PLANS have been prepared by the Texas state highway department for the construction of a low bridge over the Neches River at Dryden Crossing, near Beaumont. A petition will be sent to the war department asking the government to share in the cost of the structure, which is estimated at $677,675.

THE FOURTEENTH TEXAS SHORT SCHOOL for waterworks and sewage plant operators will be held in Mineral Wells, Tex., Jan. 18 to 21.

A COMPREHENSIVE FIELD SURVEY of the underground water distribution system of the New Orleans sewerage and water board will be undertaken on recommendation of Bryson Vallas, general superintendent. The survey, which will cost $15,000 and will require about a year, will be made by the Pitometer Co.

AS AN UNEMPLOYMENT RELIEF MEASURE, the taxpayers of Saskatoon, Sask., have approved the expenditure of $360,000 for the city's share of a new bridge to be constructed across the South Saskatchewan River connecting the main business section of the city with Nutana, a suburb. The bridge will cost $850,000 and the expense will be shared by the provincial and dominion governments.

A NOTE concerning the publication of portfolios on "Wood Sash Frames" on p. 977 of the Dec. 17 issue stated that they were free on application. The West Coast Lumbermen's Association announces that they are free merely in the "local Northwest," and that elsewhere the price for the five portfolios is $2.

CONTRACT AWARDS for public and semi-public works amounting to $28,229,530 were reported to the public works section of the President's Organization on Unemployment Relief during the week ended Dec. 29. This brings the total of contract awards reported since Dec. 1, 1930, to $2,854,131,245.

SOCIETY CALENDAR

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual convention and road show, Detroit, Mich., Jan. 9-15.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; annual meeting, Jan. 19-22, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION, Chicago; annual meeting, St. Louis, Jan. 26-29.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; thirteenth annual convention, Jan. 18-21, Milwaukee, Wis.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; fifteenth annual convention and exposition of quarry equipment and machinery and supplies, Pittsburgh, Pa., Jan. 19-22.

NATIONAL PAVING BRICK ASSOCIATION, Washington; annual meeting, Chicago, Feb. 10-12.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington; annual meeting, Pittsburgh, Jan. 27-29.

NEW JERSEY SEWAGE WORKS ASSOCIATION has outlined a tentative program for its 1932 meeting consisting of papers by W. M. Veitch, of London, Ont., on operation of an activated-sludge plant at London; by Ensley White, on operating experiences at Red Bank, N. J.; by Stephen A. Kowalchick, hydraulic engineer of the state department of health; by Mr. Wasser, Hackensack Valley sewer commissioner, on conditions in the Hackensack Valley; by R. Watson, on the Raritan situation; by J. R. Downes, on digestion of sewage solids. A poll of the society is being taken to determine whether the annual meeting shall be held on March 17 and 18 or on March 18 and 19.

PROFESSIONAL ENGINEERS OF ONTARIO at the annual meeting in Toronto unanimously adopted a resolution to sponsor a bill in the Ontario legislature restricting the practice of engineering to properly qualified persons. All the other provinces in the dominion have similar legislation. The object of the bill will be to make the association a qualifying and licensing body.

WASHINGTON SOCIETY OF ENGINEERS at its meeting on Dec. 16 elected as president A. B. McDaniel to succeed Capt. W. E. Parker. New directors include C. H. Spencer, W. M. Corse and A. H. Horton, while P. C. Whitney is secretary. An engineering guide book of Washington is being prepared under the society's direction to commemorate the bicentennial of the birth of George Washington.

A JOINT MEETING of the Metropolitan Section of the American Society of Civil Engineers and the American Welding Society will be held on Feb. 9 in New York City, at which a structural welding symposium will consider the findings of the investigation by the structural steel welding committee. Speakers will be F. T. Llewellyn, F. P. McKibben, L. S. Moisseiff and H. M. Priest.

Personal Notes

KERN DODGE, consulting engineer, has been appointed director of public safety of Philadelphia.

H. G. BARBER, of Wauseon, Ohio, has been named district engineer of the Ohio highway department, with headquarters in Bryan.

R. M. MCKINNON, who resigned as city engineer of Sydney, N. S., several weeks ago, is now assistant city engineer in Halifax, N. S.

PAUL MORTON, who has been city manager of Petersburg, Va., became the first city manager of Lexington, Ky., on Jan. 4, when that city entered on the manager form of government.

H. H. RUSSELL, superintendent of the Williamsport division of the Pennsylvania Railroad at Williamsport, Pa., has been made engineer of water service of the railroad at Philadelphia, succeeding J. A. RUSSELL, who has been made manager of water service.

IRVING MATTHEWS, formerly engineer in charge of the waterworks bureau, has been chosen city engineer of Rochester, N. Y., and C. ARTHUR POOLE, formerly consulting engineer to the city of Rochester, has been named city manager to succeed Stephen B. Story.

O. E. TAPLEY, formerly with the Arkansas highway commission but who lately has been the Southern representative of the W. A. Ridell Co. at Little Rock, Ark., will become highway commissioner for Pulaski County, Mo., on Jan. 15, succeeding Glenn D. Douglas, who has resigned as highway commissioner but will continue as county engineer.

Obituary

E. W. HARRISON, of Tacoma, Wash., contractor and owner of the E. W. Harrison Pipe Co., died in Tacoma recently at the age of 60 years.

CHARLES B. GOEDDEL, who served several terms as highway commissioner of the State of Illinois, relinquishing the position seven years ago, died on Dec. 27 at his country home near Waterloo, Ill. He was 87 years old.

JULIAN I. PRUGH, superintendent of the city water mains division at Sacramento, Calif., died Dec. 23, at the age of 51. Mr. Prugh began his work in the division in 1913 and was made head in 1921.

FREDERICK ELMER FIELD, architectural engineer, died at his home in Providence, R. I., on Dec. 31 in his 68th year. Mr. Field designed numerous public buildings in Providence and was the first president of the Providence Architectural Society.

GUY H. MILLER, of Albany, N. Y., district engineer of the U. S. Bureau of Public Roads, died on Dec. 27 after an illness of about a year. Mr. Miller, who was 59 years old, at one time was a district engineer of the New York state highway department and had been a federal district engineer from the time federal aid was started. His district included the New England States, New York and New Jersey.

Business Side of Construction

Year's Contract Value 23 Per Cent Below That of 1930

ENGINEERING construction for the year 1931 totaled $2,454,176,000, compared with $3,173,259,000 in 1930. This drop of 23 per cent in money value is offset materially by lower construction costs which have permitted a larger amount of construction per dollar than in 1930 and indeed than in any other year since 1922. *ENR* Cost Index was 194.48 a year ago, and is now 162.48—a decrease of 16½ per cent during the year, and an average of 8 per cent for the year. *ENR* Construction Volume Index is 220 for the whole of 1931, compared with 260 in 1930, a drop in structure volume of 15½ per cent.

Compared With 1930—Public-works construction maintained a lead over 1930 throughout the entire year. Classes recording higher volume than the preceding year were waterworks, bridges, and especially federal government work. Road-building was 8 per cent below; public buildings 16 per cent below. The gain for all public works was 2 per cent, thus emphasizing once more the remarkable stability of this important group.

Building continued its decline of the last three years. Value of new industrial buildings was only half that of 1930, which in turn was 40 per cent below the record year 1929. Commercial building volume was 46 per cent below that of 1930, which was 33 per cent below 1929. Residential building has been declining. All other private construction, including public-utility work, decreased 25 per cent. The drop in private construction was 42 per cent.

Volume Compares With 1925—Total value of engineering-construction contracts in 1931 compares most closely with that of the year 1925. The difference is only 4 per cent, in favor of the earlier year. But whereas last year public works amounted to 58 per cent of the year's total, this group in 1925 amounted only to 40 per cent. The gain in public work has been 37 per cent; the reduction in private construction, chiefly building, 32 per cent. Both the gain and the loss occurred in each of the six great sections of the country.

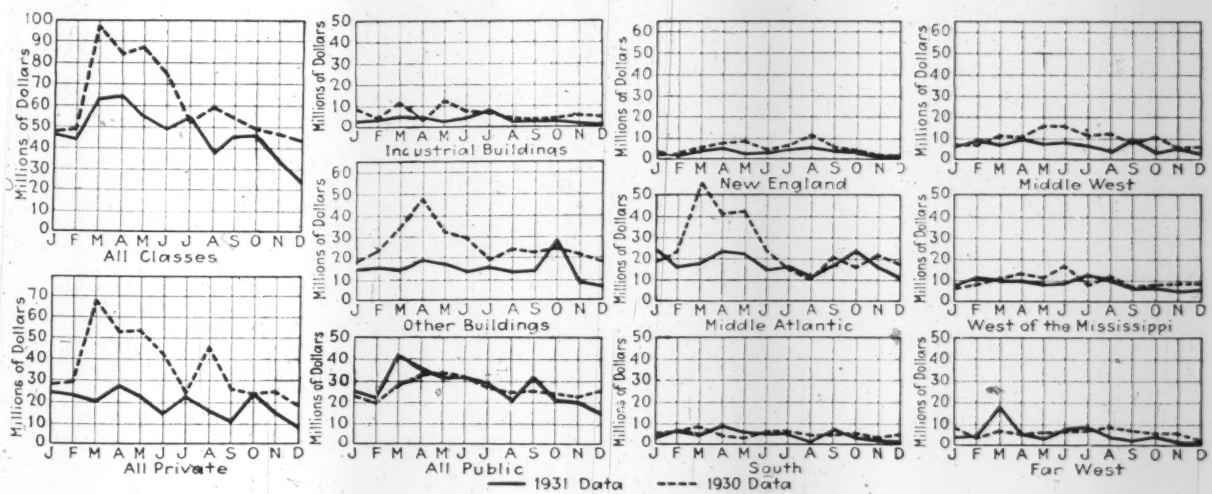
Compared With the Depression Year 1921—In the year 1921 the value of new construction was only half last year's, and every class of work was far below the 1931 volume. The accompanying table gives the dollar value of contracts for 1931 and 1921 as per cent of the values for the year immediately preceding each. The total drops were 23 per

	1931 % of 1930	1921 % of 1920	1922 % of 1921
Waterworks	116	173	95
Sewers	89	105	113
Bridges	105	88	147
Streets and roads	92	119	107
Federal government	242	78	152
Industrial buildings	50	26	168
Commercial and public buildings	61	98	134
Unclassified	72	62	162
Total	77	78	130

ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN DECEMBER, 1931

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States Dec., 1931	United States Twelve Months 1931	United States Twelve Months 1930	Canada, Dec., 1931
Waterworks	$240	$209	.....	$1,374	$296	$295	$2,414	$56,413	$48,558	$233
Sewers	114	1,537	$152	1,489	704	790	4,786	72,814	82,189	414
Bridges, public	40	1,833	236	2,678	1,782	220	6,789	125,204	109,390	850
Excavations	167	56	120	215	.....	.....	558	20,638	34,376	.....
Streets and roads	1,513	4,717	3,431	5,855	8,304	2,607	26,427	528,512	576,993	1,035
Federal government	544	5,494	1,820	1,069	5,400	2,293	16,620	280,960	116,445	.....
Unclassified, public	346	1,755	25	1,106	25	113	3,370	84,365	123,552	904
Buildings, public	3,426	7,141	800	1,310	2,075	773	15,525	248,766	297,719	596
Total public	6,390	22,742	6,584	15,096	18,586	7,091	76,489	1,418,172	1,389,222	4,032
Buildings, industrial	768	2,265	1,370	2,260	887	445	7,995	165,750	331,171	390
Buildings, commercial	2,785	18,437	.....	710	.....	905	22,837	560,650	1,033,672	150
Bridges, private	.....	.....	.....	.....	25	.....	25	11,184	20,183	.....
Unclassified, private	2,140	9,642	58	200	5,575	170	17,785	298,420	399,011	150
Total private	5,693	30,344	1,428	3,170	6,487	1,520	48,642	1,036,004	1,784,037	690
December, 5 weeks	**12,083**	**53,086**	**8,012**	**18,266**	**25,073**	**8,611**	**125,131**	.....	.....	**4,722**
November, 4 weeks	9,145	67,226	9,300	27,487	17,922	7,678	138,758	.....	.....	24,563
December, 1930, 4 weeks	10,184	71,161	22,663	24,102	32,614	12,091	172,815	.....	.....	12,116
Twelve months, 1931	185,616	968,978	234,200	379,951	396,252	289,179	.....	2,454,176	.....	129,816
Twelve months, 1930	265,254	1,288,248	270,217	533,733	490,014	325,793	.....	.....	3,173,259	187,706



Contracts awarded, showing trend by classes and sections

cent for 1931 and 22 per cent for 1921. The third column gives 1922 values as per cent of 1921 values, and shows the recovery from the depression year, an increase of 30 per cent. Further gains in engineering construction volume were registered each year to 1930.

Materials Notes

Cement—Shipments are 81 per cent below last year's figure, but stocks are 3.4 per cent lower, thus encouraging firm prices. A recent increase in imports, chiefly British, brought a request for a higher tariff rate, which the President refused. Dealers are endeavoring to stop mill shipments to jobs, by their own trucks or by trucking companies, and have succeeded to some extent at Albany, Buffalo, Philadelphia, Pittsburgh, and Youngstown.

Concrete Aggregates—Very little sand and gravel in less than carloads is being moved at present, and prices have dropped in several districts. In Minneapolis a city ordinance has been submitted, compelling dealers to sell by the ton instead of the cubic yard, the ton being easier to check.

Lumber prices trend down as follows: Boston, pine timbers and spruce, 50c.; Detroit, pine timbers, $2; St. Louis, 8-in. fir timbers, 50c.; hemlock, $1. Of 162 mills questioned, 65 expect to close during January because of insufficient orders. Stocks at 400 softwood mills total 4,007,105,000 ft. b.m., or 15 per cent lower than a year ago; but only 11 per cent has been sold, compared with 15 per cent last year.

Brick prices are down 50c., to $15, at Detroit, and $1.50, to $12, at Dallas. Neither manufacturers nor dealers have stocks, and both refuse to quote on 1932 deliveries except as needed.

Lime stocks are ample and price decreases few. Hydrated finishing grade is down $1 at Detroit and New York; common hydrated down $1 at New York.

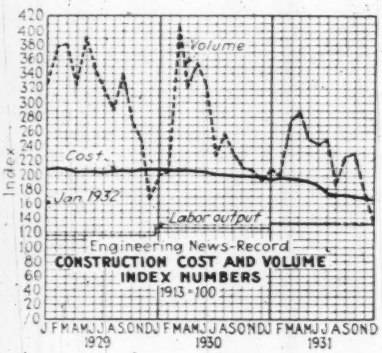
Steel—Sales of fabricated structural steel averaged 17,600 tons in December, compared with 24,400 tons a year ago. The U. S. Steel Corporation has unfilled orders amounting only to 2,934,000 tons, 19 per cent below a year ago and the smallest in twenty years. Pittsburgh price is down 10c., to $1.50; a year ago it was $1.65. Wire mesh sales have increased in the South and Northwest due to including the material in the specifications for state road work. Demand for tin plate also is active, with the Canton Tin Plate Corp., for example, operating at capacity from an average of 92 per cent for the year. Operations have been resumed at several plants: Jackson Iron & Steel, Jackson, Ohio, following six months' shut down; Wheeling Steel Corp., Benwood, W. Va., after weeks of idleness; Ensley, Ala., rail mill of Tennessee Coal, Iron & Railroad Co.

Cast Iron Pipe—Birmingham foundries are operating at 40 per cent capacity, the figure for the last three months, compared with 30 per cent for the same period last year. The only price drop was $2 at San Francisco.

Construction Cost and Volume Index Numbers

The January cost index number (162.48) is 2.5 per cent under that for December, 1931, and 16.5 per cent below the index for January 1931. The 1931 average is 10.4 per cent under that for 1930. The December volume (133) is 26.1 per cent less than that for November, 1931, and 30.7 per cent smaller than that for December, 1930. The 1931 volume is 15.4 per cent less than that for 1930.

E.N.-R. Cost		E.N.-R. Volume	
Jan., 1932	**162.48**	**Dec., 1931**	**133**
Dec., 1931	166.23	Nov., 1931	180
Jan., 1931	194.48	Dec., 1930	192
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.85	1930 (Average)	260
1913 average	100.00		
1930		1930	
January	208.96	January	199
February	206.46	February	204
March	206.80	March	408
April	207.12	April	320
May	205.86	May	354
June	203.36	June	324
July	200.95	July	226
August	200.95	August	259
September	199.58	September	232
October	198.72	October	211
November	198.54	November	207
December	196.86	December	192
1931		1931	
January	194.48	January	208
February	196.61	February	198
March	194.51	March	278
April	191.63	April	289
May	189.33	May	251
June	187.23	June	243
July	174.37	July	248
August	171.38	August	187
September	171.40	September	225
October	169.78	October	229
November	169.28	November	180
December	166.23	December	133


Index
Volume
Cost
Jan 1932
Labor output
Engineering News-Record
CONSTRUCTION COST AND VOLUME INDEX NUMBERS
1913 = 100
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1929
1930
1931

Capital and Contracts

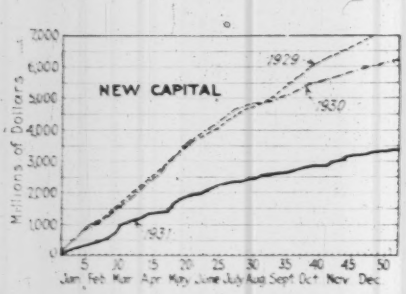
There were no issues of new capital of any kind in the closing week of 1931. A similar situation existed on one other occasion in 1931—the week of Oct. 16.

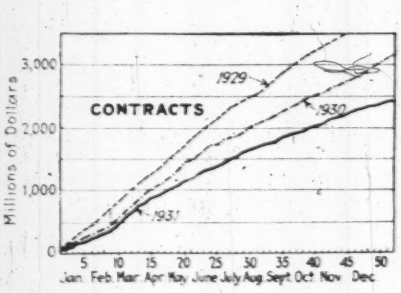
Both public and private financing declined heavily in 1931—compared with the preceding two years, according to the following yearly totals: public—1929, $2,327,000,000; 1930, $2,163,000,000; 1931, $1,930,000,000; private—1929, $4,481,000,000; 1930, $4,031,000,000; 1931, $1,458,000,000.

This week' contracts, with comparisons, areas follows:

(In Thousands of Dollars)

	Jan. 7, 1932	Average of Last Four Weeks 1932-31	1931-30
Buildings:			
Industrial	$4,574	$2,295	$3,068
Other	8,037	6,663	19,539
Streets and roads	3,568	4,275	4,537
Other construction	8,010	10,529	21,034
Total	$24,189	$23,761	$48,216
Total, all classes, Jan. 1 to Jan. 7:			
1932			$24,189
1931			104,619





MOVEMENT OF BASIC BUILDING MATERIALS

	Eleven Months 1931	Eleven Months 1930	Per Cent Change in 1931
Fabricated Structural Steel:			
Bookings, tons	1,805,600	2,536,800	—28.8
Shipments, tons	1,716,000	2,818,800	—39.2
Fabricated Steel Plate:			
New orders, tons	286,067	442,646	—35.4
Steel Ingots:			
Production, tons	23,597,796	37,306,740	—38.1
Steel Castings:			
New orders, tons	372,792	835,046	—55.5
Range Boilers:			
Production, No.	489,920	548,414	—10.8
Shipments, No.	494,214	550,666	—10.2
Stocks, No.	26,605	24,093	+10.8
Steel Boilers:			
New orders, No.	6,835,301	12,882,840	—47.0
Cement:			
Production, bbl.	118,596,000	152,425,000	—22.4
Shipments, bbl.	122,323,000	153,056,000	—20.2
Stocks, bbl.	22,223,000	23,056,000	— 3.4
Lumber (softwood):			
Production, M ft.	8,304,751	11,529,886	—27.8
Shipments, M ft.	8,869,174	11,302,343	—22.1
New orders, M ft.	8,549,804	10,993,731	—22.0
Unfilled orders, M ft.	435,512	669,435	—34.9
Stocks, M ft.	3,988,056	4,595,663	—13.0
Enameled Sanitary Ware:			
New orders, pcs.	1,685,269	2,207,153	—26.3
Shipments, pcs.	1,783,629	2,286,474	—21.9
Terra Cotta:			
New orders, tons	40,548	70,866	—42.8

Labor Notes

Contractors generally are opposed to long-term wage agreements at this time. The unions naturally desire continued recognition of the existence, at least, of the formal scale. Local conditions are given on the following page.

Boston—Carpenters accept $1.17½, from $1.37½; other unions refuse reductions.

Niagara Falls—Painters accept 25c. cut to $1 per hour, eight-hour day and five-day week.

Oswego—Though bound by a contract expiring April 1, the organized contractors have advised the unions of a 20 per cent cut effective Jan. 15.

Utica—Plumbers accept cut of $1 per day and five-day week. Carpenters and masons after voluntarily proposing wage reductions ended negotiations with the contractors.

Schenectady—Plumbers' rate is $1.50 to

May 1; employers offer $1 and the union suggests $1.25 and has called a strike.

Atlantic City—Painters and decorators voluntarily reduce wages $3.60 per day, to $8, for eight-hour day and five-day week.

Pittsburgh—Allegheny County contractors propose 25 per cent cut to the 1923 scale and 30 unions have united in opposition to it.

Birmingham—City commission is endeavoring to sell $1,130,000 of storm-drain bonds to complete work already started. Emergency unemployment program may have to be canceled.

Vicksburg—American Federation of Labor charges that contractors on government levee work are paying as low as $1.25 for twelve-hour day and fail otherwise to care for injured workmen.

Columbus, Ohio—Workmen on Columbus-Sandusky road claim to have been paid 25-30c. per hour, against 40c. prescribed for the county by the state highway department. The department threatens blacklisting and forfeiture of contract, and insists on reinbursement in the specific case.

Chicago—Of 125,000 union workers, only 30,000 are employed. The Construction Investors Trust has been formed and $50,000,000 has been pledged by construction labor, employers and materials manufacturers. The object is the revival of the industry through the elimination of slum areas and a renaissance in building.

Marion, Ill.—Bricklayers accept cut of $2 per day, to $12.

St. Louis—Bricklayers' union fined ten members $100 each for working for 50c. below rate of $1.75 on a public school job.

East St. Louis—Agreement signed for electrical workers to receive present rate of $1.65 throughout 1932, with four-day week.

Kansas City—Municipal projects financed by ten-year bonds provided work for 1,000 in December, and 3,000 men may be added this month.

Denver—State industrial commission refuses to permit lumber manufacturers to reduce wages 20 per cent, asserting $6.40 per eight-hour day small enough.

Salt Lake City—U. S. secretary of labor rules that the wage scale observed by the Associated General Contractors and the Salt Lake Chamber of Commerce shall prevail on local federal building projects.

San Francisco—The five-day week was effective Jan. 1.

ENR Average Wage Rates—Average skilled wage is $1.11, compared with $1.15 in December and $1.37 in January, 1931. Common rate is $0.4534, compared with $0.4524 in December and $0.5384 a year ago.

December Lowest Month Since 1922

December contracts for engineering construction averaged only 25 millions per week, the lowest rate in nine years. The November rate was 35 millions, and that for the whole year 43 millions. For 1930 the average weekly rate of lettings was 61 millions. The record year was 1929 with an average of 76 millions per week.

Proposed Work Includes Many Large Projects

Construction projects reported in November and December at various stages of planning prior to the call for estimates exceeded one billion dollars. *ENR* statistics for the two months are given below:

	November		December	
	Proposed	Awarded	Proposed	Awarded
Industrial buildings	$53,750	$8,837	$16,895	$7,995
Commercial buildings	95,210	38,328	109,364	38,362
Federal governm't	26,038	22,224	19,309	16,620
General construction	457,996	91,593	419,199	70,149
	$632,995	$138,758	$564,767	$125,131

The proposed work includes a number of very large projects, of which the largest ten are: $399,700,000 for New York subways; $26,000,000 Grand River hydro-electric development in Oklahoma; $23,750,000 for St. Louis hospitals; $22,800,000 for pipe lines in the Southwest; $15,000,000 for 50 theaters in California; $14,000,000 sewage-treatment plant in Cleveland; $12,000,000 Pennsylvania R.R. terminal at Newark, N. J.; $10,000,000 each for Long Island park developments and a chemical plant at Corpus Christi; $4,500,000 Reading Co. terminal at Atlantic City.

$20,000,000 Sewage-Disposal Plan for Hackensack Valley

Creation of a joint sewage-treatment district for the Hackensack River valley, including 57 cities and towns in Bergen and Hudson counties with a combined population of 456,000 in 1930, is recommended in a report by the Hackensack Valley Sewerage Commission submitted to the boards of freeholders of the two counties on Dec. 30. Two trunk sewers and two treatment plants are proposed, one to serve 50 communities in Bergen County and the other seven Hudson County cities and towns, including the part of Jersey City in the Hackensack Valley. The estimated cost of trunk sewers designed to serve until 1960 and of treatment works to serve until 1944 is about $20,000,000, with a probable need of additional treatment units by 1947 to cost $4,000,000.

The commission advises that the two counties finance construction on a 60-40 basis for Bergen and Hudson counties respectively and that the several cities and towns repay the money advanced in proportion to the amounts of sewage each delivers. The project would be administered by a commission of six non-salaried members, appointed three each by the respective county board of freeholders. This commission would operate the 40 sewage-disposal plants now in use until the completion of the two new plants, without cost to the owners of the existing plants.

The report advises that the bonds issued for the project should be outside the 7 per cent debt limit. Authorization of the project by the state legislature is necessary.

$10,000,000 Expenditure for Montreal Waterworks

Expenditures on the Montreal waterworks system during 1932, 1933 and 1934 will total $10,558,269, according to a report submitted by the water board. One project calls for $3,000,000 for a hydro-electric plant for lighting municipal buildings. This amount would cover dam, power plant and spillways for the development of 16,500 hp. Other projects include: $3,045,000 for pumping and filtration division, $2,635,000 for piping, and $2,995,000 for reservoirs and aqueducts. Construction of a 150,000,000-gal. reservoir in the east end of Montreal, to cost $2,500,000, is one of the items provided for.

State and County Do 73 Per Cent of Total Public Work

Public works reported by *Engineering News-Record* in 1931 are classified by political divisions as follows: state, 41.4 per cent; municipal, 31.3; federal government, 19.8; county, 7.3; township, 0.2 per cent.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**, declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Pile Drivers	Structural Iron Workers	Masons' Laborers	Common Laborers
Atlanta	$1.12½	$0.60@0.70	$0.60@1.00	.....	$0.75@1.25	$0.50	$0.20@.35
Baltimore	1.25	.90@1.00	1.00@1.37½	$0.65	1.00@1.25	1.00	.30
Birmingham	*.75@.87½*	*.60*	.60@.90	.....	.60@.90	.30	.20@.25
Boston	1.50	*1.17½*	1.37½	1.27½	1.37½	.85	.40@.80
Cincinnati	1.25@1.62½	1.00@1.40	1.00@1.40	1.00	1.00@1.40	.60	.40@.45
Chicago	1.70	1.62½	1.62½	1.62½	1.62½	.97½	.50@.97½
Cleveland	.90	.75@.85	1.00	1.10	.90@1.00	.50	.40@.45
Dallas	1.00@1.12½	.65@.87½	.75@1.00	.75@1.00	1.00	.35@.50	.20@.25
Denver	1.00@1.12½	.75@.87½	.75@.87½	.....	.75@.87½	.50	.31½@.50
Detroit	1.00@*1.25*	.60@.80	1.00@1.10	1.00@1.10	1.00@1.25	.50	.30@.50
Kansas City	1.62½	1.32½	1.37½	1.37½	1.37½	.82½	.25@.75
Los Angeles	1.00	.75	1.00	1.00	.87½@1.00	.87½	.50
Minneapolis	1.00@1.10	.75@.85	.80	.....	.80	.45	.40@.45
New Orleans	.60@.80	.40@.50	1.12½	.90	.80@1.12½	.50	.15@.25
New York	1.60@1.92½	1.30@1.65	1.92½	1.78½	1.92½	.93½@1.23½	.50@.93¾
Philadelphia	1.50	.90@1.00	1.02½@1.36	1.00	1.37½	.40	.40
Pittsburgh	.70@1.75	.70@1.50	.70@1.50	.....	.70@1.50	.50	.50
St. Louis	1.75	1.50	1.60@1.75	1.25	1.75	.87½	.35@.87½
San Francisco	1.37½	1.12½	1.12½	1.12½	1.37½	.87½	.50@.68¾
Seattle	87½@1.50	.62½@1.12½	1.12½@1.25	1.12½@1.25	1.12½@1.25	.70	.50@.70
Average	*1.24*	*.95*	1.16	*1.13*	*1.13*	0.67	*0.452½*
Montreal	1.12½	.75	.70	.90	.75	.35	.25@.35

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, for cement in cloth, *without including charge for four bags at 10c. each*. Cash discount not deducted. Prices are delivered by truck to contractors at site of job:

	Jan. 7, 1932	One Mo. Ago	One Yr. Ago
Atlanta	$2.25	$2.25	$3.00
Baltimore	1.87	1.87	2.60
Birmingham	2.40	2.40	2.60
Boston	*2.00*	2.10	2.35
Chicago	*1.55*	1.65	2.20
Cincinnati	1.60	1.60	2.94
Cleveland	1.25	1.25	2.80
Dallas	1.88	1.88	2.15
Denver	2.40	2.40	2.61
Detroit	1.90	1.90	2.60
Jersey City	1.79	1.79	2.33
Kansas City	2.00	2.00	2.07
Los Angeles	2.50	2.50	1.92
Minneapolis	2.15	2.15	2.50
Montreal	2.18	2.18	2.20
New Orleans	2.01	2.01	2.35
New York	1.60	1.60	2.23
Philadelphia	1.95	1.95	2.15
Pittsburgh	1.81	1.81	.....
St. Louis	2.00	1.85	2.15
San Francisco	2.44	2.44	2.64
Seattle	2.20	2.20	2.25

Current mill-prices per barrel to dealers, in carloads, without including charge for four cloth bags, f.o.b.:

Alpena, Mich	$1.20	Mason City, Ia	$1.10
Buffington, Ind	1.10	Norfolk, Va	1.61
Dallas, Tex	1.74	Northampton, Pa	1.21
Hannibal, Mo	1.10	North Birmingham, Ala	1.31
Hudson, N. Y	1.21	Richard City, Tenn	1.31
Independence, Kan	1.10	Steelton, Minn	1.61
Ironton, Ohio	1.06	Universal, Pa	1.21
Iola, Kan	1.10	Waco, Tex	1.60
La Salle, Ill	1.10	Wyandotte, Mich	1.20
Limedale, Ind	1.10		

SAND AND GRAVEL—Per ton, delivered. Gravel, sizes ¾-in. or 1½-in.:

	Gravel	Sand
Atlanta	$3.00	$2.25
Baltimore	2.35@2.55	2.08
Birmingham, per cu.yd., 2,600@2,800 lb.	2.90	2.50
Boston	*1.40@1.75*	1.00@1.20
Chicago, per cu.yd., 3,000 lb.	1.65	1.65
Cincinnati	1.50	1.25
Cleveland, per cu.yd., 3,000 lb.	2.00	2.00
Dallas, per cu.yd., 2,750 lb.	2.25	2.25
Denver, per cu.yd., 2,700 lb.	1.80	1.35
Detroit	1.65	1.50
Kansas City	2.00	2.00
Los Angeles	2.20	1.50@1.70
Minneapolis, per cu.yd., 2,800 lb.	1.70@2.40	1.00
Montreal	1.50	1.25
New Orleans, per cu.yd., 2,700 lb.	2.02½	1.28
New York, per cu.yd., 2,800@3,000 lb.	*2.75*	*1.75*
Philadelphia	2.35@3.20	1.55@2.40
Pittsburgh	1.55	1.75
St. Louis	1.65	1.35
San Francisco	1.75	1.75
Seattle, per cu.yd., 2,900@3,000 lb.	1.85	1.85

CRUSHED STONE—Per ton, size 1½-in., limestone, delivered:

Atlanta	$3.00
Baltimore	2.60@2.80
Birmingham	*Slag used*
Boston	*1.75@2.00*
Chicago, per cu.yd., 2,500 lb.	1.65
Cincinnati	2.25
Cleveland	2.50
Dallas, per cu.yd., 2,500 lb.	2.90@3.00
Denver, granite, per cu.yd., 2,700 lb.	2.50
Detroit	1.95
Kansas City	2.00
Los Angeles	2.20
Minneapolis, per cu.yd., 2,600 lb.	2.40
Montreal	1.80@2.00
New York, per cu.yd., 2,800@3000 lb.	*2.75*
Philadelphia	2.30@3.15
Pittsburgh	3.25
St. Louis	1.65
San Francisco, trap rock	1.65
Seattle, per cuyd., 3,000 lb.	3.00

CRUSHED SLAG—Prices for carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.10	1.10	2.25	.70
Western Pennsylvania	1.25	1.25	2.00	1.25*
Toledo, Ohio	1.10	1.10	1.10	1.00
Youngstown District	1.25	1.35	2.00	1.25

CONCRETE BLOCKS—Standard, 8x8x16-in., hollow, delivered to job, each:

Birmingham (5x8x12)	$0.084	Kansas City	$0.18
Boston	.16@.20	Minneapolis	.10
Brooklyn and Queens	.12	New Orleans	.18
Chicago	.23	Philadelphia	.18@.25
Cleveland	.16@.17	Pittsburgh	.20@.26
Denver	.22	St. Louis	.14
Detroit	.12		

HOLLOW TILE—Building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.09	$0.12	$0.14	$0.18	$0.24
Baltimore	.105	.....	.20	.....	.23
Birmingham	.089	.122	.167	.219	.25
Boston	*.08*	*.115*	*.15*	.21	.325
Chicago	*.048*	*.066*	*.09*	*.117*	*.13*
Cincinnati	.06815	.09485	.129	.165	.184
Cleveland	.048	.066	.09	.117	.13
Dallas	.081	.107	.141	.....	.284
Denver	.0975	.135	.175	.2125	.25
Detroit	.08	.11	.145	.19	.215
Kansas City	.088	.11	.145	.19	.215
Los Angeles	.09425	.134	.188	.2325	.3115
Minneapolis	.0611	.081	.10605	.1302	.1737
New Orleans	.085	.115	.16	.228	.255
New York	.075	.125	.14	.....	.....
Perth Amboy, N. J. (f.o.b.)	.....	.....	.....	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	.041	.058	.0845	.111	.12275
St. Louis	.07	.098	.125	.17	.20
San Francisco	.0765	.105	.1765	.....	.....
Seattle	.085	.115	.18	.....	.....

BRICK—Prices delivered per thousand are as follows:

	Common	Front	Paving F.O.B. 3x8½x4-in.	Paving F.O.B. 3½x8½x4-In.
Atlanta	$13.00	$21.50	$32.00	$37.00
Baltimore	12.50	25.00@35.00	40.00	43.00
Birmingham	13.50	22.50	27.00	32.00
Boston	14.00	28.00	47.50	52.50
Chicago	12.00	.....	42.00	43.00
Cincinnati	16.00	24.00	35.00	37.00
Cleveland	12.00@14.00	21.00@28.00	33.00	36.00
Dallas	*10.50*	17.50	.....	35.00
Denver	9.00@10.00	25.00	.....	.....
Detroit	*15.00*	25.00	*25.00*	*35.00*
Kansas City	14.00	.....	35.00	37.50
Los Angeles	9.00	26.50	.....	.....
Minneapolis	10.00	30.00	.....	.....
Montreal	28.00	.....	.....	.....
New Orleans	13.00	.....	40.00	45.00
New York	11.50	30.00	45.00	50.00
Philadelphia	16.00	.....	40.00	45.00
Pittsburgh	12.00	22.00	41.00	58.00
St. Louis	14.00	22.00	35.00	35.00
San Francisco	14.00	.....	45.00*	.....
Seattle	14.00	.....	48.50	61.00

*2½x8½x4-in.

LIME—Prices delivered to job:

	Hydrated, per Ton — Finishing	Hydrated, per Ton — Common	Lump, per Barrel — Finishing	Lump, per Barrel — Common
Atlanta	$17.50	$15.00	.....	$2.50†
Baltimore	22.00	14.00	.....	2.25†
Birmingham	30.00	17.50	.....	2.00†
Boston	21.50	14.50	$4.00*	3.10*
Chicago	13.00	13.00	1.50†	1.50†
Cincinnati	13.05	10.70	.....	.....
Cleveland	12.00	10.00	2.50†	2.50†
Dallas	20.00	.....	2.50†	.....
Denver	30.00	23.75	3.80*	3.00†
Detroit	*18.00*	12.00	*1.65†*	*1.75†*
Kansas City	19.00	18.00	2.25†	2.00†
Los Angeles	26.00	18.00	2.00†	2.00†
Minneapolis	25.50	21.00	.....	1.70†
Montreal	18.00	10.00	.....	.....
New Orleans	22.00	13.00	2.10†	1.95†
New York	*16.00*	*13.00*	4.10*	3.15*
Philadelphia	18.00	14.50	18.00‡	14.00‡
Pittsburgh	13.50	13.00	4.25*	2.75†
St. Louis	18.00	16.00	.....	12.50‡
San Francisco	17.30	17.30	.....	1.57†‡
Seattle, paper sacks	35.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

LIMESTONE—Mill blocks, f.o.b. siding, per cu.ft.:
New York: Rustic buff, *$1.37*; Standard gray, $1.47; Standard, $1.57; Selected gray, $1.57; Selected buff, $1.67.
Boston: Rustic buff, $1.45; Standard, $1.58; Selected buff, $1.71.
Pittsburgh: Rustic buff, $1.03; Standard, $1.18; Selected buff, $1.28.

SLATE—Roofing, f.o.b. quarry, Bangor, Pa., net, per square:

No. 1 Clear	$9.00@$14.00
No. 1 Ribbon	7.50@ 10.25
Medium Clear	8.00@ 10.50

Road and Paving Materials

PAVING STONE—Granite, lots of 50,000 blocks, 4x8x4-in., dressed, f.o.b. city:

Atlanta	*3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	105.00 per M.
Chicago, 5 in.	3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	90.00@100.00 per M.
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.75 per sq.yd.
Minneapolis, 4½ in.	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in.	120.00 per M.
Philadelphia	105.00 per M.
St. Louis, 5 in.	3.30 per sq.yd.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.25
Chicago	3½	12	1.80@2.00
Kansas City	3½	16	2.00
Minneapolis	3½	16	2.50
Montreal	3½	16	2.63
New Orleans	3½	16	2.30
New York	3½	14	1.90
St. Louis	3½	16	2.10

FLAGGING—Alongside dock, New York, per sq.ft.: Manhattan and Bronx, 4 ft. wide, $0.24 Queens, 5 ft. wide, $0.26

CURBING—Prices per lin.ft., f.o.b., cutting charges not included:
New York: Bluestone, f.o.b. barge, straight, 5x16-in., rough, 85c.
Birmingham: Granite, straight, 5x16-in., 50c.; 6x20-in., 60c.; roundings, 5x16-in., 65c.; 6x20-in., 80c.
St. Louis: Class "B" straight, 5x16-in., 75c.; roundings, $1.05@$1.20.

ASPHALT—Paving asphalt, f.o.b., per ton. Packages are 350-lb. bbls. or 425-lb. drums, in carload lots:

	Packages	Tank-car or -boat
Atlanta	$18.40	$15.40
Baltimore (f.o.b. refinery)	16.00	12.00
Birmingham (f.o.b. refinery)	.....	16.50
Boston	22.00	17.50
Chicago	22.50	18.30
Cincinnati	.....	12.00
Cleveland	18.75	15.50
Dallas	19.50	.....
Denver	30.00	.....
Detroit	16.68	12.43
Kansas City (f.o.b. refinery)	16.00	11.00
Los Angeles (f.o.b. refinery)	18.00	12.00
Maurer, N. J. (Bermudez)	.....	25.00
Maurer, N. J. (Trinidad)	.....	21.00
Minneapolis (f.o.b. Twin Cities)	23.10	18.10
Montreal	17.00	13.00
New Orleans	23.00	20.00
New York (f.o.b. refinery)	16.00	12.00
Philadelphia	16.00	12.00
Pittsburgh	24@26	14@18
St. Louis	22.50	18.50
San Francisco (f.o.b. refinery)	18.00	12.00
Seattle	21.40	18.00

LIQUID ASPHALT—Residual, prices f.o.b., in tank cars, 8,000 gal. minimum; 45% asphalt, per gal:

New York	$0.05
Birmingham	.06
St. Louis	.04
Dallas	.05

Iron and Steel

PIG IRON—Furnace, No. 2 Foundry, per gross ton:

	Current	Mo. Ago	Yr. Ago
Birmingham	$11.00	$11.00@12.00	$14.00
Buffalo	15.00	17.00	15.25

STRUCTURAL STEEL—Prices per 100 lb., delivered from warehouse except in Birmingham and Pittsburgh, where prices are f.o.b. mill. Beams and channels, 3 to 15 in; angles 3 to6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier:

Birmingham	$1.70	New York	$2.35
Chicago	3.00	Pittsburgh	1.50
Cleveland	2.95	St. Louis	3.25
Dallas	3.25	San Francisco	2.90

BARS, CONCRETE REINFORCING—Prices per 100 lb., delivered from warehouse except in Birmingham and Pittsburgh, where prices are f.o.b. mill, on bars rolled from billets, size ½-in.:

Birmingham	$1.75	New York	$2.35
Chicago	1.65	Pittsburgh	1.60
Cleveland	1.75	St. Louis	3.00@3.15
Dallas	2.75	San Francisco	2.50

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job:

Lb. per Sq.Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$11.00	$17.50	$10.60	$16.00	$18.00	$21.50
2.5	12.00	18.50	11.40	17.00	19.50	22.50
3.0	13.00	20.50	12.65	18.50	.....	25.00
3.4	14.00	22.00	13.65	19.25	24.00	27.00

TRIANGLE MESH—Plain, per 100 sq.ft., 4 in. x 4 in. Manufacturers' quotations are in carloads at mills; dealers' are delivered in lots of 10,000 sq.ft. or over:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Del. From Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.89	$0.91	$1.21	$1.30	$1.63	$1.22*
049	28	1.13	1.16	1.55	1.70	2.00	1.55*
068	35	1.39	1.42	1.80	2.10	2.25	1.91*
093	45	1.78	1.83	2.31	2.65	2.86	2.46*
126	57	2.20	2.26	2.85	3.30	3.52	3.03*
153	68	2.63	2.69	3.41	3.95	4.20	.....
180	78	3.01	3.09	3.92	4.35	4.80	.....

* F.o.b.

STEEL SHEETS—Prices per 100 lb. for base sizes, delivered from warehouse, except in Pittsburgh, where prices are f.o.b. mill:*

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago	$3.20	$3.55	$4.10
Cleveland	3.00	3.60	3.75
New York	2.65	3.50	4.00
Pittsburgh	1.85	2.40	2.90
St. Louis	3.45	3.80	4.35
San Francisco	3.65	4.15	4.65

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20 %
Galvanized iron rigging and guy rope (add to list)	12½ %
Galvanized steel rigging and guy rope	7½ %
Plow steel round strand rope	35 %
Round strand iron and iron tiller	5 %
"Special Steel" and extra strong cast steel, round strand rope	27½ %

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas.

Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Structural rivets, round head, ½-in., full kegs, per 100 lb., delivered from warehouse, except in Pittsburgh, where prices are f.o.b. mill:

Chicago	$3.75
Dallas	4.50
Denver	4.05
New York	4.00
Pittsburgh	2.25
St. Louis	4.00
San Francisco	5.00
Seattle	4.50

STEEL SHEETPILING—Base price, f.o.b., Pittsburgh, for large mill lots, per 100 lb. $1.90

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill: Per package $9.50

SHIP SPIKES—Per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.50	$5.05	$4.90
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $2.90 per 100 lb.

WIRE NAILS—Per 100 lb. keg, base, delivered from warehouse stocks; also Pittsburgh mill base:

Pittsburgh	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$1.95@$2.00	$2.40	$3.50	$2.40	$3.50	$2.75	$4.95

SCRAP—The prices following are f.o.b., per gross ton, paid by dealers:

	New York	Chicago	Detroit
No. 1 railroad wrought	$5.00	$6.50*	6.50
Stove plate	3.00@4.75	6.25*	4.50
No. 1 machinery cast	8.50†	8.50*	8.50*
Machine shop turnings	1.75	4.00	4.00
Cast borings	1.25	3.50	4.50
Railroad malleable	6.00	7.00	.....
Re-rolling rails	6.00	10.50	9.00
Heavy melting steel, No. 1	4.25	7.50	7.00
Iron and steel pipe	3.00	4.50	.....

*Net ton. †Delivered direct to foundries.

FREIGHT RATES—The following freight rates per 100 lb., effective Dec. 3 1931, apply on finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc.:

Atlanta	$0.58*	Detroit	$0.265†
Baltimore	.27†	Kansas City	.52†
Birmingham	.58*	New Orleans	.67*
Boston	.40†	New York	.33†
Buffalo	.235†	Pacific Coast (all rail)	1.15‡
Chicago	.34†	Philadelphia	.29†
Cincinnati	.265†	St. Louis	.39†
Cleveland	.185†	St. Paul	.59*
Denver	1.15‡		

*36,000 lb. †40,000 lb. ‡60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Standard rails have been $43.00 per gross ton since Sept., 1922 at which time the price was $40.00; other rails, per gross ton, f.o.b., as follows:

	Pittsburgh	Birmingham	Chicago
Light rails, 25 to 45 lb.	$34.00	$33.00	$34.00
Re-rolled rails	24.00@28.00	24.00@28.00	32.00

RAILWAY TIES—Prices f.o.b., per tie, for carload lots:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.00	$1.20
	Dense yellow pine, untreated	.80	1.00
Birmingham	White oak, untreated	.90	1.05
	White oak, creosoted	1.45	1.55
	Southern pine, untreated	.45	.95
	Southern pine, creosoted	1.05	1.40
Chicago	White oak, untreated	1.05	1.35
	Oak, empty cell, creosoted	1.40	1.80
	Oak, zinc treated	1.25	1.65
	Southern pine, creosoted	1.25	1.60
St. Louis	White oak, untreated	.85	1.30
	Red oak, untreated	.75	1.20
	Red oak, creosoted	1.25	1.70
	Sap pine or cypress, untreated	.60	1.10
San Francisco	Douglas fir, green, untreated	.50	.68
	Douglas fir, empty cell, creosoted	1.22	1.64
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.65

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Prices per 100 lb., f.o.b., for large mill lots at Pittsburgh and Birmingham, together with warehouse prices at other places named:

	Pittsburgh	Birmingham	Chicago	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.70	$2.70	$3.45	$3.65	$4.10
Track bolts	3.80	3.70	4.30	4.50	5.10
Standard section angle bars, splice bars or fish plates	2.75	3.00*	5.75	.....	.....
Tie plates	1.95	2.07½	1.95†	.....	.....

*At warehouse. †At mill.

Pipe

WROUGHT STEEL PIPE—Discounts from standard lists for delivery from warehouse, except at Pittsburgh, where prices are f.o.b. mill. List prices per ft. as follows: ⅜-in., 17c; ¾-in., 76½c; 3½-in., 92c; 6-in., $1.92.

	1 to 3-In. Butt Weld		3½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago	57.25%	44.71%	53.83%	41.29%
Cleveland	53.3%	42.3%	50.8%	37.8%
New York	56.14%	43.6%	52.72%	40.18%
Pittsburgh	64%	52.5%	61%	49.5%
St. Louis	51%	38%	48%	35%

CAST-IRON PIPE—Prices per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots (250 tons and under) of pipe:

	4-In.	6-In. and Over
Birmingham mill	$35.00@$36.00	$32.00@$33.00
Burlington (N. J.) mill	35.00@ 36.00	32.00@ 33.00
Chicago	43.00@ 44.00	40.00@ 41.00
New York	38.00	35.00
Pittsburgh	43.50@ 44.50	40.50@ 41.50
St. Louis	42.80	39.80
San Francisco	*43.00@ 44.00*	*40.00@ 41.00*

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.105	$0.175	$0.315	.....	.....	.....	.....
Baltimore	.10	.30	.58	.....	$1.93	.....	$6.50
Birmingham	.135	.225	.405	$0.85	1.625	$3.18	4.38
Boston	.18	.28	.55	1.35	2.375	3.95	5.90
Chicago	.18	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	.405	1.05	1.89	3.456	5.4325
Cleveland	.1125	.175	.3375	.825	1.485	4.824	7.38
Dallas	.23	.325	.586	1.106	1.95	3.68	5.00
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	*.55*	*1.35*	*2.60*	*4.75*	.....
Kansas City	.21	.335	.52	1.22	1.90	3.60	.....
Los Angeles	.217	.2825	.4985	1.1865	2.034	3.95	9.00
Minneapolis	.155	.24	.50	1.15	1.85	3.45	4.60
Montreal	.30	.45	.75	1.95	2.60	.....	7.20
New Orleans	.17	.28	.52	1.00	1.90	.....	.....
New York	.17	.265	.52	1.30	2.34	4.47	6.86
Philadelphia	.0945	.147	.297	.80	1.44	2.304	3.28
Pittsburgh	.1575	.245	.54	1.25	2.25	4.68	7.17
St. Louis	.1295	.235	.423	1.05	1.80	3.20	4.40
San Francisco	.21	.30	.54	1.26	2.16	3.60	5.40
Seattle	.22	.30	.54	1.26	2.16	2.50	5.50

CLAY DRAIN TILE—Prices delivered per 1,000 lin.-ft.:

Size, In.	New York	Birmingham	Pittsburgh	Chicago	St. Louis	San Fran.	Seattle
4	$42.00*	$50.00	$80.00	$40.00	$50.00	$67.50	$60.00
6	*75.00	85.00	110.00	100.00	85.00	112.50	112.00

*F.o.b.

Miscellaneous

LINSEED OIL—Raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:
New York *$0.077* Minneapolis *$0.084*

WHITE AND RED LEAD—Base price per 100-lb. keg, f.o.b., New York: White, dry, *$12.00*; White, in oil, *$12.00*; Red, dry, *$12.00*; Red, in oil, *$13.50*.

CHEMICALS—Water, sewage treatment, road work, f.o.b., carlots, New York:

Sulphate of aluminum, in bags, per 100 lb	$1.25
Sulphate of copper, in bbl., per 100 lb	*5.10*
Soda ash, 58%, in bags, per 100 lb	1.15@1.17½
Chlorine, cylinders, per lb	.04
Bleaching powder, in drums, f.o.b. works, per 100 lb	2.00
Calcium chloride, flaked, in drums, f.o.b. works, per ton	*21.00*

MANILA ROPE—The number of feet per pound for the various sizes is as follows: 5-in., 7-ft.; 6-in., ¼-in., 6-ft.; 1-in., ½-in., 4-ft.; 5-in., 1-in., 3-ft.; 8-in., 1¼-in., 2-ft.; 9-in., 1¼-in., 1-ft., 8-in. Following prices are quoted by dealers per pound for ¼-in. and larger:

Atlanta	*$0.18*	Kansas City	$0.23
Baltimore	.225	Los Angeles	.175
Birmingham	.25	Minneapolis	.18
Boston	.20	Montreal	.185
Chicago	.175	New Orleans	.20
Cincinnati	.21	New York	.17
Cleveland	.21	Philadelphia	.21
Dallas	.22	St. Louis	.17@.175
Denver	.20	San Francisco	.175
Detroit	.185	Seattle	.175

BUILDING PAPER—Black, 50-lb. per roll of 500 sq.ft., in carloads, f.o.b., producing point $2.16

SLATERS FELT—In carloads, per roll, f.o.b. producing point $0.79

ROOFING MATERIALS—Prices, f.o.b. New York, delivered to contractors, in carloads:

Asphalt felt, per 100 lb	$2.50
Tar felt, per 100 lb	2.50
Asphalt coating, per gal	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFING—Prices, delivered to contractors, in carloads, f.o.b. New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.50
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	6.25
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—Discounts from latest jobbers' window-glass list, dated Sept. 15, 1928, at New York warehouse:

	Single Thickness		Double Thickness	
	A Quality	B Quality	A Quality	B Quality
First 3 brackets	89%	91%	88%	90%
Larger sizes	88%	90%	88%	90%

EXPLOSIVES—Price per pound for dynamite delivered:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles	$0.1725	$0.1925
Baltimore	.215	.2375	Minneapolis	.20	.225
Birmingham	.135	.157	Montreal	*.17*	.195
Boston	.225	.25	New Orleans	.195	.22
Chicago	.17	.195	New York	.245	.2675
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	*.185*	*.21*	St. Louis	.1975	.2175
Denver	.19	.2125	San Francisco	.155	.18
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

Lumber

Prices Are Delivered, Per M Ft., B. M., No. 1 Common, Rough

New York—Timbers, to contractors, at site of job in Manhattan, in 20-ft. lengths and under:

	Long-leaf Yellow Pine	Douglas Fir
3x4 to 8x8	$45.00	$29.00
3x10 to 10x10	52.00	30.00
3x12 to 12x12	63.00	31.00
3x14 to 14x14	70.00	35.00

Chicago—Timbers, pine, in 20 ft. lengths and under; fir, up to 32 ft:

	Long-Leaf Yellow Pine	Douglas Fir
3x4 to 8x8	$42.50	$42.50
3x10 to 10x10	49.50	44.50
3x12 to 12x12	62.50	44.52
3x14 to 14x14	72.51	45.50

San Francisco—Douglas fir timbers:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$35.00	$37.00
3x6 and 8	35.00	37.00
3x10 and 12	35.00	37.00
3x14	38.00	39.00

Other Cities—Timbers, boards, etc.:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine	Fir	Hemlock	Spruce	Pine	Fir
Atlanta	$40.00				$55.00	
Baltimore	35.00	$48.00	$52.00	$58.50	72.00	$48.00
Birmingham	46.00				76.00	
Boston	*50.50*	46.00	46.50	*48.00*	*56.50*	43.00
Cincinnati	42.50	55.00	.....	.....	52.50	52.50
Cleveland	54.00	54.00	.....	.....	52.00	52.00
Dallas	55.00	*47.50*	55.00	55.00	55.00	*47.50*
Denver	.....	55.00	55.00	.....	.....	55.00
Detroit	53.00	51.00	.....	.....	*63.00*	51.00
Kansas City	35.00	35.00	35.00	.....	55.00	40.00
Los Angeles	.....	41.50	.....	.....	.....	42.50
Minneapolis	.....	46.25	.....	.....	.....	46.25@47.75
Montreal	.....	41.75	.....	40.00	40.00	41.75
New Orleans	38.00	38.00	.....	43.00	63.00	58.00
Philadelphia	45.00	42.00	36.00	40.00	55.00	40.00
Pittsburgh	53.00	57.00	65.00	66.00	43@57	57@60
St. Louis	*40.00*	*37.50*	*38.00*	.....	54.50	39.00
Seattle	.....	16.00	.....	.....	.....	15.00

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine	Fir	Hemlock	Pine	Fir
Atlanta	$40.00			$35.00	.....
Baltimore	52.00	$43.00	$42.00	.....	.....
Birmingham	40.00	.....	.....	55.00	.....
Boston	46.00	41.00	41.50	47.00	$45.00
Cincinnati	45.00	47.50	.....	35.00	45.00
Cleveland	44.00	37.00	37.00	42.00	54.00
Dallas	60.00	.....	.....	55.00	.....
Denver	.....	36.00	36.00	.....	45.00
Detroit	*48.00*	45.00	.....	43.00	43.00
Kansas City	40.00	40.00	.....	35.00	33.00
Los Angeles	41.50	41.50	.....	.....	48.50
Minneapolis	65.00*	40.00	.....	45.00*	39.00
Montreal	45.00	*43.25*	40.00	.....	*36.25*
New Orleans	*59.00*	*59.00*	.....	54.00	48.00
Philadelphia	48.00	40.00	35.00	49.00	40.00
Pittsburgh	40.00	47.00	55.00	40.00	50.00
St. Louis	38.50	39.00	39.00	41.00	40.00
Seattle	.....	15.00	.....	.....	16.00

*Northern Pine, No. 2 Com.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.10	$0.165
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.145	.215
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.17	.235
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.205	.345
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.2225	.295
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.285	.395
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.325	.435